Vol. II SEPTEMBER, 1916 No. 9

The INTERNATIONAL JOURNAL OF ORTHODONTIA

A Monthly Journal Devoted to the Advancement of the Science of Orthodontia

MARTIN DEWEY, D.D.S., M.D., Kansas City, Mo.
Editor-in-Chief

H. C. POLLOCK, D.D.S., St. Louis, Mo.
Associate Editor

JAMES DAVID McCOY, D.D.S., Los Angeles, Calif.
Editor, Department of Dental and Oral Radiography

PUBLISHED BY
THE C. V. MOSBY COMPANY
SAINT LOUIS

$3.00 Per Annum Single Copies, 30 Cents

The International Journal of Orthodontia

Editor: Martin Dewey, D.D.S., M.D.

VOL. II | ST. LOUIS, SEPTEMBER, 1916 | NO. 9

ORIGINAL ARTICLES

DENTAL ENGINEERING

BY RUDOLPH L. HANAU, NEW YORK CITY.

IN my introduction to the dental profession, I adopted the designation "Consulting Dental Engineer," implying thereby, that I had enlisted in a consulting capacity to the profession in meeting and solving the intricate problems of orthodontia.

Before I ever thought of dentistry, my time was largely occupied in solving such problems as other men in my profession did not care to attempt, i.e., I specialized in solving extraordinary and unusual problems.

I was consulted by Dr. F. L. Stanton to design a device for outlining a denture, a device which should prove more efficient than the method of employing the compass, as had been his custom before. The resulting method was given in a joint paper by Dr. F. L. Stanton and myself read in San Francisco before the Panama-Pacific Dental Congress in 1915. In the same paper the apparatus which I constructed is described. During my association with Dr. Stanton he taught me the laws of occlusion, the sequence in the eruption of the teeth, and many other things pertaining to orthodontia; the last word, I will confess, had not, previously, been included in my vocabulary.

In the course of my investigations, my attention was called to a paper by Dr. Hawley on the "Dental Arch." After diligent study of the treatise, in which a brilliant attempt is made to classify or standardize the dental arch, I immediately became dubious, whether the hypothesis warranted any such attempt inasmuch as hardly two dentures were found to be alike,—either as a whole, respectively, or in their respective subunits.

After I understood the axiomatic laws pertaining to occlusion, there was no doubt in my mind that it was erroneous to assume that various dentures could be represented by similar geometrical figures, and it also nonplused me that these geometrical figures should consist of an arc of a circle and two straight lines, which, mathematically speaking, would mean that there were two points in the figure where the character of the curvature suddenly changes.

Dr. Stanton showed me several dentures but I could never recognize the arc of a circle and two straight lines, although in some dentures a curve of asymptotic character could be observed where the straight line was supposed to be. There was another feature totally neglected in the laying out of the dental arch as it had been presented to me by Dr. Stanton: Although the Curve of Spee was pointed out to me, it had not been considered in the delineation of the arch form. In other words: the dental experimenters laying out the arch, were plotting in two dimensions only, while there were actually three to be considered. I recognized that here was an untrodden field in science, complicated in its nature, but for that reason all the more interesting. I trust that my criticism will be appreciated as no efforts to minimize the value of existing methods, but as a frank differentiation between what is wrong and right. An engineering problem, such as the plotting of the dental arch presents, requires a thorough knowledge of descriptive geometry, kinematics and mechanics; it cannot, therefore, be reasonably expected to be solved,—truly solved,—by experimenters who lack the necessary training.

The writer, as already intimated, would, in all likelihood never have undertaken his researches relating to the denture, had not his attention, through a chain of circumstances, been focused upon the lack of understanding on the part of those who pretended to understand and others who swallowed the cookery at hand.

The denture, as a mechanism, is a very awkward and inefficient machine. The supervising engineer in a modern shop would never permit such an apparatus to "pass the gate." He would relegate it to the upper shelf of the model room, somewhere near the perpetual motion devices and locomotive model which is provided with legs instead of wheels as locomotion implements.

But, inasmuch as homo sapiens will not—in the near future—be called upon to supplant the said inefficient and awkward apparatus, named the dental apparatus, with a more perfect mechanical device, we may just as well console ourselves with the discovery that the denture is one of the most important parts of our organism and has highly ornamental properties, provided it is in fairly good condition.

Where scientific bases are lacking, esthetics are impressed to fill the gap. Often we are advised that artistic judgment (artistic prejudice is a better term) is to govern our endeavors to attain what might prove to be correct. It follows that guess work is employed, instead of cold scientific reasoning, and that in a measure is controlled by the inclination, skill, or the routine habits of the guesser. The employment of this pseudo-analysis makes it easily possible that through the respective influences of climate, altitude, whim or weather, or any of a hundred conditions, one and the same individual,—searcher after truth,—will come to various conflicting refutations of the same problem. All conclusions would of course be equally incorrect; it but devolves upon the scientist to view the accomplishment through an animated kaleidoscope. Dentistry cannot claim a monopoly of the conditions here exposed; such or similar conditions prevail also in most other professions,—probably in all.

The pseudo-scientific results which we so often lightly take for granted, are directly caused by the natural static inertia of the human mind.

When guess work has been pursued sufficiently long we like to call it "good judgment," when it has been recorded we all like to call it "science," and when we have finally committed it to memory we call it "experience."

The scientist will not always be able to distinguish between the theoretical and practical value of his study, but he will always endeavor to evolve applicable, exact methods because he knows that every intelligent, practical man will gladly substitute precise and logically correct methods for empiricism and "rule of thumb" methods. Practice will automatically eliminate the unessentials. In this spirit "Dental Engineering" is presented to the dental profession.

Dental engineering is the branch of theoretical engineering that has allied itself with practical orthodontia. It will and should give orthodontia the preciseness of investigation and accuracy of interpreting results that modern engineering possesses. It should widen the field extensively and invite and command the interest of true scientific men.

An article published by my former collaborator, Dr. F. L. Stanton, in the *International Journal of Orthodontia* (Vol. II, No. 5), and also papers read by others whom I have interested in dental engineering, convince me that the work that I have initiated, and am pursuing, has already aroused the interest of and demonstrated its usefulness to the dental profession.

In a paper read before the American Society of Orthodontists, at Pittsburg, July 21st, 1916, many of my findings are recorded, and they will be published by the society. From time to time I intend to present further results of my investigations, and, if they are found worthy by the editor of this Journal, they will, probably, be brought directly before its readers.

I seek and invite the co-operation of dental men, for only with their assistance will I, as an engineer, be able to attain results in this new field, which I am confident will justify its existence.

RETENTION

By Frank R. Woods, D.D.S.

Instructor in Orthodontia, College of Dental Surgery, University of Michigan, Ann Arbor, Mich.

PART II.

In a former article was discussed certain general considerations in retention, and it is my purpose to continue this a little further before going into the intimate details of construction and application of appliances.

The forces of occlusion and malocclusion are identical and the resultant structures are in the one case, a harmonious development, and in the other, inharmony and confusion, only because we have in the first a proper balance of these forces in direction and degree, and in the second, a lack of it.

Now during the retention period these forces of occlusion are, of course, our very light and hope of success, but, owing to the fact that they are now active under a new set of conditions, which, inasmuch as they are the result of a relatively

rapid mechanical stimulation, are entirely artificial in character and more or less altered in degree, and these forces will have somewhat different values, perhaps, than we are wont to ascribe to them in the process of erupting a normal dentition.

In order to better understand their action we will enumerate the ones we consider most active in the changes accomplished during retention. They are, Cell Metabolism, Action of Occlusal Inclined Planes, Muscular Pressure, Normal Proximal Contact, and Harmony in the Size of the Arches. These forces have long been recognized by writers in orthodontia. I think there may well be added to the above the term, Temperamental Energy, as being a descriptive term which may be applied to the individual in a somewhat comprehensive way. As applied in an orthodontic connection it embraces, in essence or in consequence, a combination of cell metabolism, muscular activity, and influence of occlusal inclined planes. It includes cell metabolism because the metabolic activity of every cell interacts to produce the general physical and nervous tone of the individual, and the metabolic rate or pressure is in turn sustained and stimulated by this general temperamental energy or activity.

The concrete or clinical manifestations of this force are exemplified in the general bearing of the patient. The individual in whom this factor is high, will be alert; his every motion will be purposeful and decisive. When his jaws are in the position of rest, the teeth are not only in contact, but the muscles by which the jaws are closed are under a positive tension, and metabolic processes are mechanically stimulated to a distinctly greater degree than is the case in the absence of this stimulus.

It is but another exemplification of the law that growth and development are promoted by active function. In such an individual the upbuilding of related hard and soft structures of the face will progress prosperously, and, the degree to which this development is necessary to bring about harmony with the realigned arch, being considered, it will be accomplished in a minimum time. It will, moreover, give the greatest possible prospect of permanency, because the forces which have induced it have been the temperamental energy of permanent active muscular and nervous habit.

We have, of course, assumed that the general health of the patient is unimpaired by disease.

We shall now consider clinically the reverse of this type. Where our first type has been the very personification of energy and activity, the second portrays lassitude, indecision, and inactivity. The facial lines and angles are indeterminate and loose. The teeth with the jaws in the positon of rest are not quite in contact, and the muscles which accomplish the closure of the jaws, together with the orbicularis oris and its attached associated muscles, are under no habitual tension, but are flabby and show a fatty interspersion or possible degeneration. There is a lack of any constant mechanical stimulus to the circulation and consequently to cell metabolism. Here is exemplified the negative result through the same law of development according to degree of activity of function as that under which our first type experienced such a happy result. Development occurring in this case is likely to be slow, the tone of the new tissue lower, and its prospective permanency less certain. I do not mean that tooth movement will necessarily be difficult. In fact, the reverse is the usual experience, but, having been moved, there is a ready tendency to return to positions of malocclusion, which, I believe, is much

greater than in cases of the positive, first type. This type will be often met in its extreme form in Class II, Division 1, cases. Much of the difficulty of retention of these cases is due to these subnormally functioning facial muscles. In treating this type, only endless patience and double vigilance will avail. Retention can be proved sufficient only by years of care and months of waiting after removing each part, for the whole organization lacks the metabolic and functional tone which makes for permanency in orthodontic correction.

(To be continued.)

A PECULIAR ACCIDENT

By Frederick S. McKay, D.D.S., Colorado Springs, Colo.

THE case with which this short article deals, was the victim of such a peculiar accident, if such it could be called, or to express it in better terms, so peculiar an experience, that it has been deemed worthy of description.

The lad of about nine years of age had been raised with difficulty and was in every sense of the term undeveloped which was in no way more conspicuously evident than in the dental arches.

It was a matter of apprehension to his parents and physician that the function of mastication was almost suspended, for as expressed by them it was "too queer to see him eat."

Judging from the occlusion it is evident that most of the masticatory func-

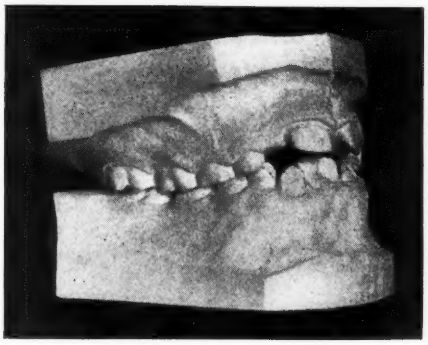

Fig. 1.

tion was performed upon the right side (Fig. 1), either because of the shortening of the vertical height of the arches on the left which allowed the cusps of the upper molars to close almost onto the gingival margins of the lowers, or else because of the tumefied condition of the gums on that side, which rendered mastication uncomfortable if not actually painful (Fig. 2, A and B).

The probabilities are that there were two distinct causes as above outlined, each sufficient in itself and yet intensifying each other.

When the case was first seen it was evident that the condition of the gums upon the left side was due to the presence of subgingival calcular deposits, plainly visible, upon the temporary molars, and more and more am I becoming impressed,

after continued observation, that, as a rule, orthodontists fail to recognize gingival irritations before commencing treatment.

From the present standpoint in viewing the significance of these early gingival irritations, it can be considered as nothing short of reprehensible to proceed with the placing of appliances without first planing smooth the rough etched surface of the enamel just under the gums and in the interproximal spaces, with the well-known planes which are available for this purpose, or referring the patient into the proper hands for such service.

The criticisms of the general practitioner regarding the irritation of orthodontia appliances have been well merited, and in my estimation these irritations

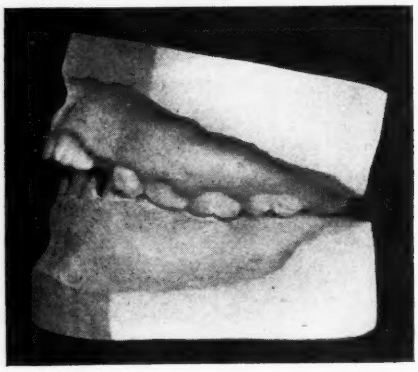

Fig. 2-A.

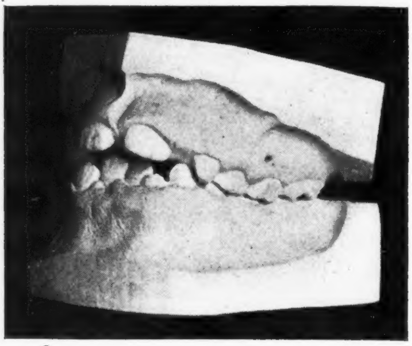

Fig. 2-B.

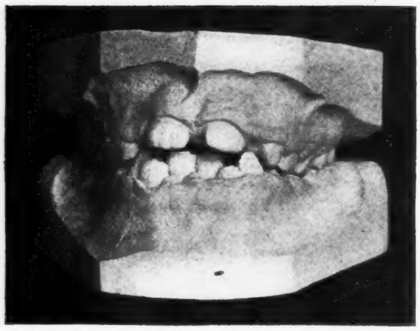

Fig. 3.

Fig. 4.

have been largely due to failure to properly administer this subgingival treatment.

To proceed, however, with the story; the treatment for enlargement of the dental arches was carried on during the winter and spring months and retainers were placed just before the boy was taken to a mountain resort for the summer.

During an exhibition the lad fell off a grandstand and both permanent upper central incisors were knocked out of the mouth onto the ground.

They were picked up and the boy taken to the dentist in the little mountain town who cleansed the dislodged teeth, opened the pulp canals, removed the contents, and filled the canals, and then reinserted the teeth into the sockets and ligated them to the retainer.

In replanting the teeth, however, in some unexplainable way they were transposed, the left one being put into the socket of the right side and vice versa, and I saw him about two weeks after the accident they had become quite firm, so that their transferal to proper position was deemed unwise. Fig. 3 shows the case as it was originally. Fig. 4 shows the present appearance, and there they must remain for how long we don't know, but the history of such cases seems to be that their loss will eventually occur through absorption of the roots.

THE PRINCIPLES OF ANCHORAGE

By Martin Dewey, D.D.S., M.D., Kansas City, Mo.

Professor of Dental Anatomy and Orthodontia, Kansas City Dental College; President of The Dewey School of Orthodontia.

PROBABLY no division of orthodontia requires as much attention or has been responsible for so many failures as anchorage. Only during the last few years have practitioners of orthodontia reached a point where they have been able to classify anchorage according to certain principles and always have some definite idea in view in the construction of the appliance, so as to follow out fundamental laws. In the movement of the malposed teeth, the most important thing to consider in the beginning is the question of anchorage. Angle states, "The movement of one or more teeth in any of the several directions is possible only by the exercising of force and its intelligent application in accordance with the laws of the mechanics and dynamics. . . . According to the well-known laws of physics, action and reaction are equal and opposite, hence it must follow that the resistance of the anchorage must be greater than that offered by the tooth to be moved, otherwise there will be displacement of the anchorage and failure in the movement of the teeth to the extent, or, probably, in the direction desired." Guilford[1] also states that, "The use of force for overcoming resistance and causing malposed teeth to assume their proper position falls within the domain of that branch of physics known as dynamic. . . . The movement of the teeth like the movement of other bodies is regulated and controlled by certain general principles or laws, the proper understanding of such of them as are important to us in our work is necessary in order that the required operation may be performed intelligently and in a scientific manner." It is therefore seen that the writers recognized that anchorage had to deal with certain mechanical forces which are recognized in other branches of mechanics. Angle and Guilford both refer to the old physical law, namely, action and reaction are always equal and opposite. In other words, just as much force as is exerted on the malposed tooth must be overcome by the anchorage.

If we had an unlimited field to work in or could make conditions or construct our anchorage according to our desires there would not be so many difficulties encountered in the movement of malposed teeth. However some of the difficulties which we have to encounter are summed up again by Guilford in which he says: "To construct a machine which by its action will accomplish a desired result may be easy, but to devise one that will give us the best results,

[1]Guilford: Orthodontia, 4th edition.

without waste of energy or an imposing ill-result requires familiarity with the principles upon which it is to operate and the attendant conditions which may limit or control its action." The last two parts of the quotation refer more particularly to the difficulties which we have to master in the treatment of malposed teeth, namely, we must be familiar with the principles upon which the appliances operate and in addition to that we must be familiar with the structure upon which we are going to operate or anatomic surroundings which make the obtaining of our anchorage difficult or impossible. Lastly Guilford mentions, "The attendant conditions which may limit or control its action." This is especially true in a case of a regulating appliance which must be confined within the oral cavity and must be so constructed as not to cause a great amount of pain or inconvenience. In other words, our space is limited and the objects upon which we are compelled to operate in securing the anchorage have already been arranged for us. If we had an unlimited amount of space and could attach to some object which would absorb an unlimited amount of force, a great many of the problems which confront us in orthodontia would not be so difficult. However, as we have stated, things must be taken as we find them and in summing up the conditions which we have to contend with and which we must understand, Angle[2] states that "An accurate knowledge of the forms and surfaces of the teeth and their occlusion, the surfaces, length, and inclination of their roots, and the structure, density and distribution of the alveolar process and peridental membrane is essential to an intelligent application of the principles of anchorage. The degree of resistance offered by different teeth varies greatly, according to their position, size, length and number of roots, the direction from which force is exerted, and in a manner of mechanical attachment to them."

Anchorage is defined by Pullen[3] as "The resistance selected as a base from which force is to be delivered for the movement of the teeth." This definition applies particularly to anchorage as employed in orthodontia, but as we have said before the principles of anchorage in orthodontic operations are the same as they are anywhere else. A more simple definition would be to say that anchorage is the resistance to overcome an applied force. It makes little difference where this resistance is obtained for as long as we have the resistance we have an anchorage. Guilford, in speaking upon the necessity of secure anchorage, illustrates this point as follows: "A jackscrew, for instance, placed under a house to elevate it exerts as much pressure upon the ground as it does upon the building, but as the resistance of the ground or foundation is much greater than that offered by the house, the latter rises when the screw is turned." In that instance we have a case in which the resistance is so much greater than the object that there is practically no moving of the resistance, but the object to be moved moves the entire distance.

Quoting Guilford again, he says, "If the jackscrew was placed horizontally between two piles of equal size implanted in the earth to the same depth, each would move equally when the screw was turned, because one offered no more resistance than the other, action and reaction being always equal."

In the second illustration we have a case of the resistance of the anchorage

[2]Angle: Malocclusion of the Teeth, 7th edition.
[3]Pullen: Johnson's Operative Dentistry.

and the resistance of the object to be moved being the same, therefore both objects move. Pullen states, in considering anchorage, that, "this resistance may be obtained from the teeth singly or in multiple, or from the top and back of the head by means of a headgear, and, except in the reciprocation of anchorage should always be greater than the force to be delivered from it in the movement of the teeth." This then brings us to the consideration of the sources from which anchorage is secured or the points from which we can obtain our resistance in the movement of the teeth. In considering the different forms of anchorage Lischer[4] classifies them first, *as to methods*, in which we give stationary and reciprocal, and secondly, *as to course*, into intermaxillary, intramaxillary, and extramaxillary.

We are here compelled to recognize two different factors which we must consider, namely the method of obtaining anchorage and the source from which it is obtained. Guilford says, to secure as stable anchorage as possible, therefore, we must resort to one of the following methods: (1) Combine the resistance of several teeth. (2) Counterbalance the force exerted upon the anchor tooth or the teeth in one direction by another force in the opposite direction, thus making the force reciprocal. (3) Use the teeth in one jaw to resist the force applied to move the teeth in the opposite jaw—intermaxillary. (4) Obtain anchorage or resistance at some point outside of the mouth or back of the head. It will be seen by studying this classification by Guilford that we get our resistance from teeth in one arch, teeth in the opposite arch, or from a point outside the mouth. This corresponds to the intramaxillary, intermaxillary, and extramaxillary anchorage as outlined by Lischer. We also notice in studying Guilford's analysis that he takes into consideration the resistance obtained from several teeth or the resistance obtained by balancing forces exerted in different directions, which gives us reciprocal anchorage, it being a form of intramaxillary anchorage. In considering the classification of anchorage a little farther, we notice that the resistance is obtained from a single tooth or may be obtained from one or more teeth, which makes it necessary to divide our anchorage according to the number of teeth which are used.

To Lischer's classification, which includes the method of obtaining the anchorage and the source from which it is obtained, we can also add a third group, which includes the number of teeth from which the anchorage is obtained. In the seventh edition of Angle's "Malocclusion of the Teeth," we find the different groups of anchorage which he describes, named regardless of the source, the method, or the number of teeth employed. The first form of anchorage described by Angle is named "Simple Anchorage," which is described as "that form in which the resistance is overcome by means of an anchor tooth or teeth of large size or more favorable location, and second, the form of attachment, to both anchor tooth and the teeth to be moved is hinged or pivoted, admitting of the tipping of both in their sockets." This definition of simple anchorage really includes two separate and distinct types, one of which depends upon the resistance being obtained from a single tooth, the other from a number of teeth. However, in both cases, the resistance is obtained from a tooth or teeth which is or are larger or more favorably located. Simple anchorage as described by

[4]Lischer: Orthodontics.

Angle is therefore one form of intramaxillary anchorage, because the resistance and the malposed teeth are both located in the same arch. He also describes stationary and reciprocal anchorage which are also forms of intramaxillary anchorage because they depend upon the method in which the appliance is attached to the anchor tooth. Stationary anchorage is described as "that form in which the attachment to the anchor tooth is essentially rigid so that the tipping is impossible and if moved at all it must be dragged bodily through the alveolar process in an upright position."

This form differs from that which Angle describes as simple anchorage because in simple[5] anchorage, the attachment of the anchor tooth is essentially pivotal, or hinged, so if sufficient force is supplied on the anchor tooth, the anchor tooth will tip, but in stationary anchorage, the same kind of a force may be applied to the anchor tooth, but owing to the construction of the appliance, the anchor tooth must be dragged bodily. This illustrates what we mean by methods of attachment, which influences the classification of anchorage.

The third form of intramaxillary anchorage such as Angle describes is known as reciprocal anchorage which he says is not a distinct type of anchorage, with which I disagree. Reciprocal anchorage is as much of a distinct type as "simple" and stationary, because it derives its name from the methods in which the appliance is attached to the anchor teeth and the malposed teeth. In other words, in reciprocal anchorage, the appliance is so constructed and attached that the force of one malposed tooth is pitted against another malposed tooth with the idea of moving both into the line of occlusion. In reciprocal anchorage, the construction of the appliance is such that the action and reaction are both utilized, to induce the movement of a malposed tooth.

We have mentioned these three types of anchorage as described by Angle to illustrate what is meant by methods of attachment or construction of appliance in order to give different forms of anchorage. Each one of these three types may be further modified or classified according to the number of teeth which are employed, whether a single tooth is used for anchorage or whether a number of teeth are used for anchorage.

In giving an outline of the classification of anchorage, as we understand it today, we first divide anchorage according to the origin from which the resistance is retained. The oldest form which we know anything about probably is intramaxillary anchorage, which is divided into three types according to the methods in which the resistance is retained from the teeth.

Intramaxillary anchorage is that form of anchorage in which the resistance necessary to overcome the malposed tooth is located in the same arch in which the malposed tooth is located. We have the three types as described by Angle, which are named primary (which is the same as Angle's "simple" anchorage), stationary, and reciprocal. Primary anchorage is that form of anchorage in which the resistance necessary to overcome the malposed tooth is derived from a tooth or teeth larger or more favorably located. That type of primary anchorage in which the resistance is obtained from a single tooth, we call simple primary anchorage because we have but a single tooth, while that form in which we enlist two or more teeth is known as reinforced or compound.

[5]We now call the form of anchorage which Angle described as simple anchorage and which is also called "Simple" in the author's book, "Practical Orthodontia," *primary anchorage*, to avoid confusion which arises in speaking about anchorage when classified according to numbers.

Stationary intramaxillary anchorage is that form in which the appliance is so constructed and attached to the anchor tooth that if the anchor tooth be moved at all, it must be dragged bodily through the process. This distinction is mentioned in comparison to primary anchorage, for in primary anchorage you do not depend on obtaining any resistance from the attachment or construction of the appliance; the entire resistance is obtained from the size and location of the tooth. In primary intermaxillary anchorage, we must necessarily use an anchor tooth, which is large and strong. This is not necessary in stationary intramaxillary anchorage, because in the construction and attachment of the appliance we can so favor our anchor tooth that a tooth of equal size will give sufficient resistance to overcome or move its neighboring tooth. In other words, one central incisor can be made to give resistance to move another central incisor. One premolar can be made to give sufficient resistance to move another premolar or even one premolar can be made to give enough resistance to move a canine, and this resistance is obtained through the construction and attachment of this appliance to the anchor tooth. Stationary anchorage, like primary anchorage, may be divided into simple or compound, depending upon the number of teeth which are enlisted in that form of anchorage.

Reciprocal intramaxillary anchorage is that form of anchorage where the resistance necessary to overcome one malposed tooth is obtained from another malposed tooth, with the idea of moving both in the line of occlusion by utilizing the action and reaction obtained from the appliance. Reciprocal anchorage can be divided first into simple and compound, depending upon the number of teeth which are employed. It can also be divided into stationary and simple, depending upon whether the anchor tooth is allowed to tip or is made to move bodily through the process. As a result of this you will readily see that reciprocal intramaxillary anchorage admits of more combinations, of a greater variety of classes; and owing to the fact that it does admit a greater variety of classes, it becomes more complicated and more difficult to understand than any form of anchorage we have mentioned heretofore. Reciprocal anchorage is also the most useful owing to the fact that we utilize action and reaction and none of the force exerted by the appliance is allowed to go to waste.

The next division of anchorage is based upon the source of obtaining a resistance, and is known as *intermaxillary anchorage,* which is defined as that type of anchorage in which the resistance is obtained from an arch different from the one in which the malposed tooth is located. In other words, the resistance necessary to move a malposed tooth or teeth, is derived from a tooth or teeth located in the opposite arch.

Intermaxillary anchorage, admits of the same divisions as intramaxillary anchorage, namely, according to the number of teeth moved, simple and compound. As to the manner of resistance obtained from the teeth, namely primary, stationary and reciprocal.

The third type of anchorage depending upon the force applied, is *extramaxillary anchorage,* of which we have three types, named according to the anatomical point from which the resistance is obtained. They are: occipital anchorage, which is obtained from the occiput region, facial anchorage, which is obtained from the maxillary teeth, and cervical anchorage, which is derived from the cervical vertebræ. However, in both cases, the resistance is obtained from a tooth or teeth which are larger or more favorably located.

(To be continued.)

AN EXPERIMENTAL INVESTIGATION OF THE PHARMACOLOGICAL ACTION OF NITROUS OXIDE

By D. E. Jackson, Ph.D., M.D., St. Louis, Mo.
Associate Professor of Pharmacology, Washington University Medical School.

IN the years 1844 and 1846 a peculiar and immortal glory fell upon the dental profession. For in the first of these years Horace Wells, a dentist of Hartford, Connecticut, first used nitrous oxide as an anesthetic in the extraction of teeth. In 1846 William T. G. Morton, a former pupil and partner of Wells, first made known to the world and publicly demonstrated the anesthetic properties of ether. Thus the earliest practical beginnings of modern analgesia and anesthesia must be credited to the dental profession. It has accordingly seemed especially appropriate that this article, the major portion of which has already appeared elsewhere,[1] might also be published here, for the great majority of American dentists will scarcely have access to the former publication.

Since this article deals almost entirely with the oldest of the modern anesthetics, nitrous oxide, it may be of further interest to add that many of the modern nitrous oxide machines have been devised either by dentists or by others who have had in mind especially the needs of the dental profession while developing these forms of apparatus.

In the early days nitrous oxide was administered pure or almost pure, air being very generally excluded. This led to the production of asphyxia after a very brief period and thus the duration of the anesthesia was necessarily short. At a later period it was appreciated that a certain admixture of air with the gas was feasible and even often improved the character and extended the duration of the anesthesia. In 1868 E. Andrews of Chicago first used pure oxygen with nitrous oxide. This was a great advancement, which, although not generally appreciated at that time, has now come to be fully recognized as indispensable in the scientific administration of nitrous oxide.

Some months ago I devised a closed method for the administration of nitrous oxide and other anesthetics in conjunction with oxygen. I have used a number of different types of apparatus in connection with this method one of which has been described in a former publication.[2] My chief object in the present article is to discuss certain features of the pharmacological action of nitrous oxide as studied by this method. No morphine, scopolamine or other hypnotic has been used in any of the experiments herein reported.

I may refer briefly to an improved form of apparatus which I have used in these experiments (Fig. 1). A rotary pump of less capacity than that used in the device previously described is attached to a very much smaller and more compact frame. The chief object in this has been to simplify the apparatus and to reduce its size and weight. A number of valves, tubes, etc., shown in the illustration have been found by experience to be unnecessary, but in the experimental development of the device they were included as precautionary measures. The apparatus carries only two tanks, one for oxygen and one for nitrous oxide, for experience has shown that since tanks need to be renewed only at con-

siderable intervals, and, if the breathing bag be filled moderately full at the moment when either tank becomes exhausted there will be ample time to remove the empty tank and replace it by a new one before a fresh supply of the gas (generally oxygen, of course) is required. Realizing the great value of simplicity and lightness in any form of apparatus intended for constant use, I have spent much time and energy in trying to produce as simple a device as possible. It is perfectly evident that the apparatus here shown is much more complicated than it need be, but for the benefit of others who may be interested in the sub-

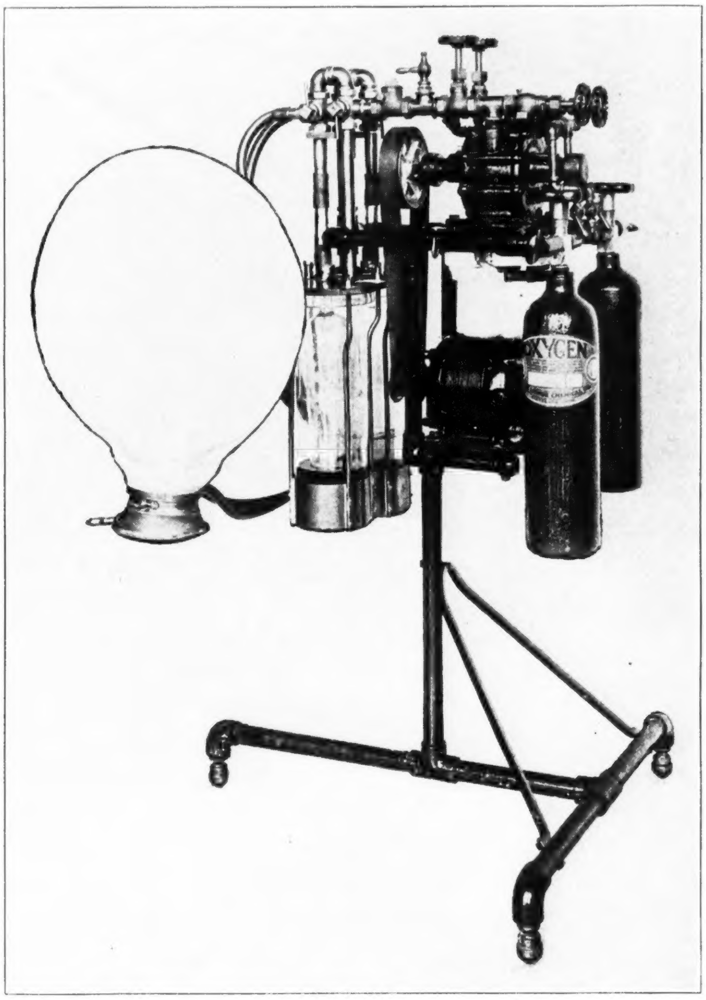

Fig. 1.—Nitrous oxide apparatus with large bag as used for experimental purposes. (For discussion, see text.)

ject of nitrous oxide anesthesia, I have thought it worth while to include here an illustration of the apparatus with which much of the work discussed below has been carried out. For a detailed description of the general principles on which the device is operated I must refer the reader to the article indicated above. By further reference to the diagram shown in Fig. 2 it will be seen that by means of a motor and a rotary air pump, air or other gaseous or volatile substances (chiefly nitrous oxide and oxygen so far as the present article is con-

cerned) are kept circulating within a closed system of tubes and vessels, and through a breathing bag into and out of which the animal breathes.

The vessels are two in number and consist of glass jars, the one containing sulphuric acid which serves to sterilize, dry and warm the air (or gases) which are washed through the acid, while the other jar contains sodium hydrate solution through which the air or gases, including the exhaled CO_2 from the patient are washed. The CO_2 is immediately absorbed by the sodium hydrate forming sodium carbonate and water according to the following equation:

$$2\ Na\ OH + CO_2 = Na_2\ CO_3 + H_2O.$$

The sodium carbonate being a soluble salt of course remains in solution (to-

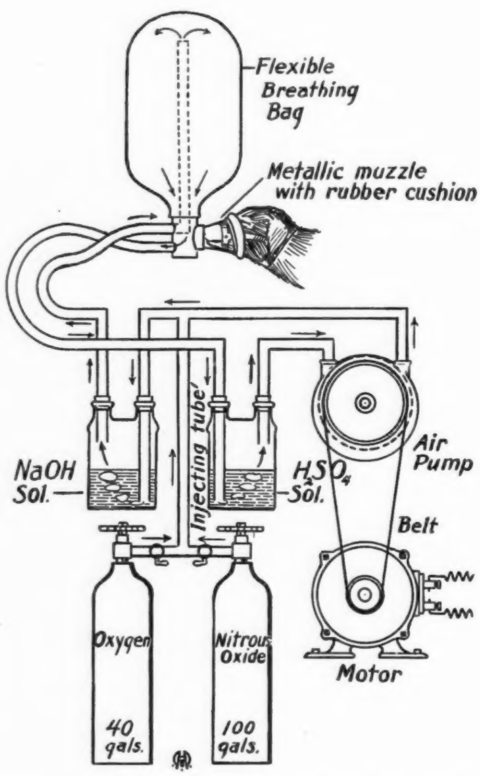

Fig. 2.—Schematic diagram to explain the plan of construction of the apparatus shown in Fig. 1. The motor turns the rotary air pump which keeps the air (or gas and oxygen) circulating. (For discussion, see text.)

gether with the H_2O formed) in the jar, the CO_2 being thus removed from the air (or nitrous oxide and oxygen) which the animal breathes. During this process the oxygen is consumed (250 to 300 c.c. per minute for an adult man at rest) by the animal or patient. More oxygen is injected into the system from time to time in just such quantities as the animal actually consumes. The nitrous oxide, being a stable gas, is not broken down at all either by the animal or by the acid or sodium hydrate. Consequently there need be but little waste of the N_2O and only a small amount (experimentally I have estimated that from $1\frac{1}{2}$ to 3 gallons will be necessary for a man weighing 160 pounds) is required to saturate the blood sufficiently to produce anesthesia. When a given amount of

N_2O is injected into the closed system and breathing bag, the animal, whose lungs virtually form a part of the closed system, will at once begin to absorb N_2O into its blood from the pulmonary alveolar walls. This absorption goes on until an equilibrium in the quantity of N_2O contained in the animal's blood and tissues on the one side and that contained in the breathing bag and tubes on the other is established. It is important, however, to remember in this connection that the affinity of the blood and presumably of the central nervous system is greater for N_2O than is the affinity of water for N_2O. So far as is known at present N_2O does not form any special chemical combination with the blood or other tissues of the body. It is apparently held in solution in the blood and tissues in the same way as any other indifferent gas dissolves in a liquid, i.e., in direct proportion to the partial pressure exerted by the gas on the liquid. The lipoid content of the blood and central nervous system is generally considered to account for the increased solubility of the gas in these tissues over that in water.

The breathing bag and face-piece shown in Fig. 1 are also modified considerably from that which I first used. The bag shown here I have found well adapted for experimental observations. It is chiefly from this standpoint that I want to discuss the action of nitrous oxide in this article. This bag holds three gallons, but the sides of the bag are flat and when not in use fall together as the air or gas passes out. When in use only about one or two gallons of air or gas need be injected into the bag and this permits the subject to have a full and free opportunity to breathe in any way he pleases. It is desirable that no excess pressure, as from an overfilled bag, be introduced to embarrass the breathing of the subject. The excess amount of work which may thus be easily thrown on the respiratory apparatus in the course of an hour may be astounding, as a brief mathematical calculation will readily show. And the problem is still further complicated both directly and indirectly by the embarrassment to the heart and lung circulation which the amount and peculiar application of this excess work involves. A further feature to be noted in the face-piece is the large opening, about three and one-half inches in diameter, which connects the bag to the air cushion resting on the face. Thus the subject breathes almost directly into the large flexible bag and obstruction of the respiration is reduced to a minimum. While this bag and face-piece serve very well for experimental observations, there are certain objections which may be made to them from a practical standpoint. The first of these is the difficulty of making an air-tight contact between the subject's face and the rubber cushion on the face-piece. The second is the inconvenience of having the large bag near the patient's head. At present, however, I wish to avoid any extensive discussion of the clinical side of this subject.

THE GASES INVOLVED IN NITROUS OXIDE ANESTHESIA.

The pharmacological relations of at least four gases must always be considered in nitrous oxide anesthesia. These are N_2O, oxygen, CO_2, and nitrogen. And it may be worth while to remember that a small amount of argon, neon, crypton, xenon, etc., are also present. Ordinarily these gases are supposed to be inactive in the animal organism, but under the peculiar conditions established in the gaseous content of the body under nitrous oxide anesthesia, I am inclined to

believe that the presence of these substances, at least at the beginning of the anesthesia, should not be entirely forgotten.

It should be emphasized that the method which I have here used permits investigation of peculiar gaseous relationships which no other device heretofore employed for this purpose could well reveal. For by this method the supply of the four gases (N_2O, CO_2, N, and O) concerned in the animal's respiration may be separately and independently controlled. The CO_2, of course, is eliminated by the animal, but it may be allowed to accumulate in the breathing bag for experimental purposes and its relative action in combination with the other gases thus studied. The relative effects of CO_2 and O in ordinary forms of breathing and in asphyxia have been thoroughly studied by numerous investigators.[3] When, however, nitrous oxide is introduced, the conditions are very materially changed and only a small amount of work has been done on this phase of the problem.

It was supposed by Sir Humphrey Davy that nitrous oxide was decomposed in the body which thus became flooded with an excess of oxygen which was promptly changed to carbon dioxide. This carbon dioxide then acted as a depressant and caused the anesthesia. It was later shown that nitrous oxide was not thus broken down but was excreted by the lungs in the same form as that in which it had been absorbed. The theory then became prevalent that nitrous oxide acted solely by excluding oxygen from the tissues and that its action was chiefly a matter of asphyxia. That asphyxia may, and in practice certainly does often play a considerable part during the production of the anesthesia, no one at present doubts. But it has been thoroughly established that nitrous oxide possesses distinct specific depressant powers of its own on the central nervous system. In 1897 Kemp[4] published a series of observations on the gaseous content of the blood during nitrous oxide anesthesia. He drew off blood from the femoral artery of dogs anesthetized with various mixtures of N_2O and air and of N_2O and O, and found that complete anesthesia could be produced by the gas when the blood contained quantities of oxygen fully capable of maintaining consciousness and of carrying on the ordinary process of metabolism. When nitrogen was substituted for the N_2O, the percentage of oxygen breathed remaining the same, the anesthesia gradually passed off and the animal regained consciousness. And it has been found by the late Sir Frederic W. Hewitt[5] that a mixture of nitrous oxide 80 per cent and oxygen 20 per cent (the amount present in air) is fully capable of producing anesthesia in suitable subjects. These observations prove beyond doubt that N_2O possesses specific depressant powers on the central nervous system. .It has also been shown by Kemp as well as by others that under N_2O anesthesia the CO_2 content of the blood is greatly reduced below the normal. But in most cases, however, it has been found that the oxygen content of the blood is reduced in even still greater degree below the normal than is the carbon dioxide. As ordinarily administered N_2O causes the nitrogen (and presumably the argon, etc.) contained normally in solution in the blood and tissues to be rapidly washed out of the system. Kemp's blood analyses for the dog show in several experiments a complete absence of nitrogen from the gases drawn off by the vacuum pump. It is to be noted that in all other forms of anesthesia the nitrogen (about 1.7 vol. per cent) remains dissolved in the blood.

Does the absence of this supposedly inactive gas in any way affect the anesthesia? In many instances I have observed dogs going under the influence of N_2O in which it appeared to me very probable that the elimination of this nitrogen was essential to the production of successful nitrous oxide anesthesia. It is, unfortunately, extremely difficult to prove this point. For one must, as a general rule, empty out most of the air (nitrogen) from the apparatus (and lungs and tissues of the animal) in order to fill this space with nitrous oxide so as to be able to obtain a sufficiently high percentage of the gas to produce the anesthesia. This makes difficult the solution of the question as to whether or not the absence of the nitrogen in any way influences the nature of the anesthesia.

In most forms of nitrous oxide apparatus used heretofore breathing had to be carried on under a greater or less degree of pressure. It is interesting to consider what influence, if any, this may have in tending to dam back the CO_2 produced in the tissues. While this gas did not apparently accumulate in large quantities in the blood in the analyses made by Kemp, still one is inclined to suspect that the tissues may have been trying to form the ordinary amounts of the gas but were either unable to do so or else they could not pass it over to the blood. And any such accumulation of CO_2 in the tissues may very well influence the nature of the anesthesia produced. And similarly any of the immediate precursors of CO_2, if allowed to accumulate in the tissues or blood, may affect the character of the anesthesia produced.

THE SYMPTOMS PRODUCED BY NITROUS OXIDE.

I have studied this topic both from the standpoint of animals and from that of man.

A frog placed in an atmosphere containing a high percentage (90% to 98%) of N_2O becomes well anesthetized in from three to four minutes. When again placed in fresh air the animal fully recovers in about one minute. Profound anesthesia is readily obtained.

The symptoms in dogs vary greatly with the animal and the method of administration. Fig. 3 shows a record of the respiratory movements in a dog just beginning to inhale N_2O. The animal was lying quietly on the table and made no resistance in any way. The record was obtained by tying a stethograph around the chest wall and connecting it by rubber tubing to a recording tambour. The first part of the tracing shows the normal respiratory movements when the animal was breathing a sufficient percentage of oxygen and the CO_2 was not allowed to accumulate to excess. At the point indicated N_2O was run into the breathing bag and shortly thereafter the depth of the respiration began to increase. This is mainly due to the action of N_2O. It is the typical effect of this gas on the respiration. There is one other point to be considered in the experiment, however, and that is the fact that in this case when the N_2O was run into the bag then the oxygen which the bag contained was considerably diluted. This would also cause the animal to breathe more deeply. But independently of this dilution of the oxygen, the first effects of nitrous oxide in sufficient concentration appear to be to stimulate the respiratory center. After a time, as the animal passes more fully under the influence of the gas, the depth of the respiration decreases while the rate varies somewhat, but on the whole is accelerated beyond

the normal. This does not seem to be due to any accumulation of CO_2 in the breathing bag or apparatus, for it is very easy to wash out the CO_2 as fast as it is formed. The animal usually does better, however, if a certain amount of rebreathing and CO_2 accumulation is permitted.

These same phenomena occur in the human subject. It is very interesting to experience the beginning action of the gas. If one fills the bag partly full of oxygen and breathes this for a while (washing out the CO_2), he may at first note a very slight sense of fullness in the head and possibly there may be a feeble flushing of the skin especially of the face and neck. Whether this is due to a slight CO_2 accumulation in the lungs (dead space, etc.), caused by the small amount of obstruction to the normal respiration, or is due entirely to excitement or the mere feeling that one "expects something" I have not been able to determine. It is of but little consequence, however, and soon passes off as one ad-

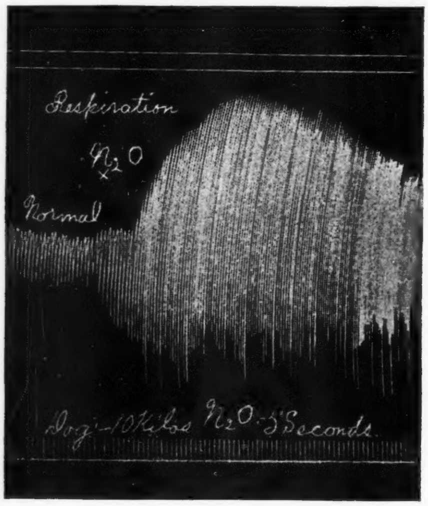

Fig. 3.—This tracing shows the respiratory movements of a dog to which (at X) nitrous oxide (plus oxygen) was administered. There is a slight mechanical exaggeration of the respiration record because the animal had been breathing mainly with its diaphragm before the gas was given, but after this the chest movements became much increased. The stethograph recorded more of the thoracic movements than it did of the abdominal.

justs himself to breathing into and out of the bag. Slight odors, as from a new rubber bag, or of oil from the pump, etc., sometimes cause one to be a little apprehensive. And the mere act of fixing the attention on the respiration is sufficient to cause certain minor variations in most subjects. When the N_2O is turned on, however, there is an immediate feeling of ease in breathing. The sensation can best be compared to the effect of oiling a new machine. One is somewhat surprised how readily he can breathe deeply and fully and without special exertion. This sensation does not occur if one instead of running nitrous oxide into the bag, should fill it to a corresponding degree with oxygen. I have been inclined to believe, therefore, that it is due to a direct stimulation of the respiratory center by the N_2O. I have considered the question of whether or not the processes of diffusion of the gases in the lungs, or the rate or ease of absorption or excretion of the oxygen or CO_2 through the alveolar epithelium might be influenced in any way by the presence of N_2O rather than of nitrogen. I have

not been able to reach any conclusion on these matters. It seems probable that certain obscure changes are produced in the metabolism of the tissues on account of the subnormal CO_2 and oxygen content of the blood, as shown by Kemp. It would be interesting to know whether or not these low percentages of CO_2 and oxygen persist in the blood in those cases in which anesthesia is produced by approximately 80 per cent N_2O and 20 per cent oxygen as in Hewitt's experiments. I have occasionally believed that in rare instances in dogs which were fully anesthetized I could raise the percentage of oxygen in the bag to perhaps 30 per cent without allowing the animal to revive. In this case, of course, while I might markedly increase the percentage of oxygen in the bag, I did not correspondingly lessen the amount of N_2O in the animal and in the apparatus. In this feature there is a great difference between the apparatus which I have here used and most other forms of nitrous oxide machines, for in these if the amount of oxygen administered is increased, this generally means a *corresponding diminution of the amount of N_2O given with correspondingly increased chances for variations in the character of the anesthesia.*

I have noted only occasionally, as have a number of my students, that just as one begins to breathe a fairly concentrated mixture of N_2O, there may be detected a faint metallic sweetish taste on the tip of the tongue. The sensation reminds one of the taste of saccharine. In my own case this taste has never lasted for more than a second or two, but one student was able to detect it over a prolonged period. It is probably due to N_2O carried in the blood from the lungs to the taste organs.

It will be noted from Fig. 3 that the animal did not struggle as the gas was administered. In some cases I have seen dogs go quietly to sleep and apparently never be conscious at all that they were being anesthetized. In a gentle animal which is especially susceptible to the gas, this may frequently occur. It is by no means the rule, however, and there is often struggling especially if the animal was excited before the anesthesia was started. It is well known that certain human subjects are especially resistant to the gas and I have frequently found this to be true for dogs. In some cases I have been entirely unable to obtain any true anesthesia at all. In these cases cardiac slowing and other complications nearly always come on as one attempts to crowd the gas. This appears to be partly due to stimulation of the vagus center in the medulla for section of the vagi usually accelerates the heart and this is generally even more marked after atropine. I have seen three or four especially striking cases of this kind. An animal which is excited or struggles is much more liable to manifest these cardiac symptoms. After atropine the animal usually takes the gas considerably better, indicating better aeration of the blood in the lungs from the improved circulation. The slowing of the heart may be very marked and apparently may be the cause of death in some cases. I have not taken string galvanometer tracings of the hearts of these animals, but this would be instructive. It has seemed to me in one or two instances that peculiar arrhythmical contractions were set up in the heart and that this finally ended suddenly either with complete stoppage of the heart, or with the establishment of a condition resembling heart block. The cause of these reactions is not at all clear. One would suspect a lack of oxygen, or CO_2 poisoning, but when the CO_2 is well washed

out of the gases breathed and the conditions are the same as those under which other animals have been well anesthetized, then one is inclined to look for a difference in the animals. I suspect that very nearly, if not quite this same thing, may have occurred in a few instances in man.[6] For that reason I wish to refer briefly to Fig. 4 which is a tracing of the apex beat of a dog which was given nitrous oxide. The animal was not a good subject, but was finally apparently well anesthetized. After the anesthesia had continued for perhaps half an hour, the pulse in the femoral artery became irregular and finally stopped rather suddenly. With considerable difficulty the animal was revived by means of intermittent compression of the chest. But when the respiration was restored, the animal did not promptly regain consciousness and remained in a semicomatose or somnolent condition for two or three hours. It was noticed about five hours after the animal revived that the heart was irregular and the tracing here shown was made. The animal improved and in about a week the heart had apparently returned to normal. The animal was kept for forty days thereafter, but no further cardiac disturbance was observed.

It seems evident to me that the human subject must be very much more susceptible to nitrous oxide than is the average dog. The anesthesia in all cases is

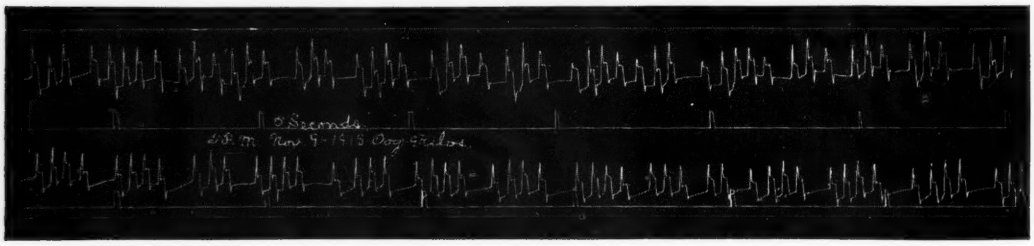

Fig. 4.—Tracings of the apex of the heart in a dog in which under nitrous oxide anesthesia cardiac irregularities developed. For a full description, see text. This tracing was taken about five hours after the animal had been anesthetized. At this time it was observed by Mr. John A. Higgins that the animal was in a dazed or semicomatose condition, and that the heart beat was very abnormal. The record here shown was then made.

of a much lighter form than that produced by ether. In dogs it is as a rule impossible to destroy the corneal reflex, for in the deepest anesthesia in these animals the slightest touch of the cornea or eye lid or even eye lashes causes immediate winking. The eyes remain open and keep up peculiar rolling or staring movements so that one often wonders whether or not the animal is fully anesthetized. If the gas be removed suddenly, however, the animal wakes up and stares about in a way which shows that it had been completely unconscious. During the anesthesia the pupils are dilated but the light reflex is preserved.

THE ACTION OF NITROUS OXIDE UNDER VARYING CONDITIONS.

If pure N_2O be inhaled, unconsciousness results in a period of from thirty to sixty seconds. But if oxygen be added to the inhaled gas, the time required to produce unconsciousness rapidly increases as the oxygen rises from zero up to five, ten or more per cent. With more than ten or twelve per cent oxygen content mixtures of nitrous oxide and oxygen usually produce unconsciousness only after considerable periods or not at all, depending on the patient. There seem to be great variations in this respect, however, in the human subject, and

I have noted a similar reaction in animals. I should like to emphasize this point in particular since it has a direct bearing on the administration of nitrous oxide by the method which I have here used.

It will be noted by reference to Figs. 1 and 2 that there is a considerable "dead space" in the apparatus. The wash jars, tubes, pump, etc., and the breathing bag all represent space which in the beginning contains air. When the animal is connected to the apparatus then its lungs also add "dead space" to the system. This "dead space" contains oxygen and nitrogen. The oxygen can be readily used up by the animal, but the nitrogen must be gotten rid of. The amount of this nitrogen depends on the construction, size, etc., of the apparatus and on the size of the animal. The blood (and tissues) of the animal also contain about 1.7 per cent of nitrogen which presumably diffuses out into the lungs and is then breathed out when nitrous oxide and oxygen are administered. It is necessary to remove a large part of this nitrogen from the apparatus to secure the best success. This is done by filling the bag partly full of nitrous oxide and running the pump for a while. The animal breathes the mixture of air and N_2O and absorbs a portion of the gas, while at the same time some of the nitrogen in its blood is breathed out. The sodium solution and the sulphuric acid in the wash jars also absorb some nitrous oxide. In a little while the bag is emptied out into the air. This is accomplished by opening a valve on the right (positive) side of the machine while the pump is running. In one or two seconds the bag can be emptied as much as desired and then more N_2O is run in until the bag is about one-half or two-thirds full. This is repeated about three or four times as a rule with dogs. One should not hurry this process. It usually takes at least five minutes to anesthetize a dog deeply and any attempt to crowd the gas faster generally excites the animal and does not improve the anesthesia. It is better to proceed slowly and allow the animal's blood to become as nearly saturated as possible for each concentration of the N_2O. In this manner the action of the drug is brought on slowly and in a perfectly successful experiment the animal may be fully anesthetized apparently without being conscious that anything unusual is occurring. Often it is not necessary to give any oxygen until the animal is anesthetized, for the oxygen in the apparatus and in the lungs, etc. ("dead spaces") serves to keep the animal in good condition for some time. When needed, however, more oxygen should be injected.

It may seem that five minutes is an unreasonably long time to require for the production of nitrous oxide anesthesia. We should remember, however, that much more time than this may be required with ether, etc., and when we think of anesthetizing an animal in thirty to fifty seconds with nitrous oxide it is interesting to consider the possibility of doing this same thing with chloroform or ether vapor which are exceedingly well absorbed by the blood. And it is probable that in any rapidly produced nitrous oxide anesthesia there may be a considerable element of asphyxia which is undesirable.

In this connection I should like to refer to some physiological experiments[7] on respiration which involve certain features usually concerned in nitrous oxide anesthesia.

"1. *The Immediate Effects of Total Rebreathing (Due Chiefly to Excess Carbon Dioxide).*—The nostrils are compressed with a nose-clip and the sub-

ject breathes from and into a rubber bag containing 20 to 40 liters of air. The amplitude of respiration is soon augmented, and in the course of a few minutes the subject is panting heavily forty times a minute. He usually develops a typical carbon dioxide headache, but this wears off in fifteen or twenty minutes after the experiment is ended." These results are produced by breathing for a *"few minutes"* into a closed bag. If in addition to these effects, which are due chiefly to carbon dioxide accumulation, there be added the further effects of oxygen want which are usually present from the very beginning in the administration of nitrous oxide, what will be the results of these purely physiological phenomena when complicated by the addition of nitrous oxide in those forms of apparatus in which rebreathing into and out of a closed bag is carried on for considerable periods of time?

"2. *The Effects of Insufficient Oxygen Without Excess of Carbon Dioxide.*—The above mentioned bag is refilled with 20 to 40 liters of fresh air and the experiment performed again, but with this difference, that a vessel of 1 or 2 liters capacity filled with soda-lime or broken sticks of sodium hydrate is placed between the bag and the subject's mouth so that he breathes through it into and from the bag. The carbon dioxide exhaled by the subject is thus absorbed, and he gradually consumes the oxygen in the bag. As a rule there is *no noticeable deepening or quickening of the breathing,* and the subject will first become cyanosed and then unconscious without appreciable augmentation of breathing. This experiment should *always be carefully supervised,* as it is not free from danger. If continued for more than ten minutes, it is usually followed by a severe frontal headache, developing slowly for several hours thereafter, together with other ill effects and lasting from twenty-four to forty-eight hours." It is particularly interesting to consider this experiment in connection with those forms of nitrous oxide apparatus in which the patient inhales the gas (plus a varying but usually small amount of oxygen) from a tank or reservoir and then exhales out into the open air. In these machines the carbon dioxide is probably fairly completely removed as fast as it is exhaled from the lungs. The small percentage of oxygen usually given (e.g., from two to ten or twelve per cent) with the nitrous oxide may cause a rather close simulation of the conditions established in the above experiment in which *cyanosis* and *unconsciousness* may be produced *without any anesthetic.* I should like to give one further quotation bearing on this point from Haldane and Poulton.[8] * * * "Still more sudden exposures to anoxemia occur when air containing little or no oxygen is breathed; for in this case the oxygen previously present in the alveolar air, and even in the venous blood, is rapidly washed out; the result is that consciousness is suddenly lost *without evident preceding hyperpnea,* although abundance of CO_2 is present in the arterial blood. Haldane and Lorrain Smith observed sudden loss of consciousness after 50 seconds on breathing air which was afterwards found to contain 1.8 per cent of oxygen. During any exertion the loss of consciousness is still more sudden. Thus it is a common experience with miners going into an atmosphere of nearly pure fire damp (CH_4), or climbing up so that their heads are in the gas, that they drop suddenly as if they were shot."

I do not care to discuss this point further, but may state briefly that my own experiments, together with the results obtained by others, have led me to

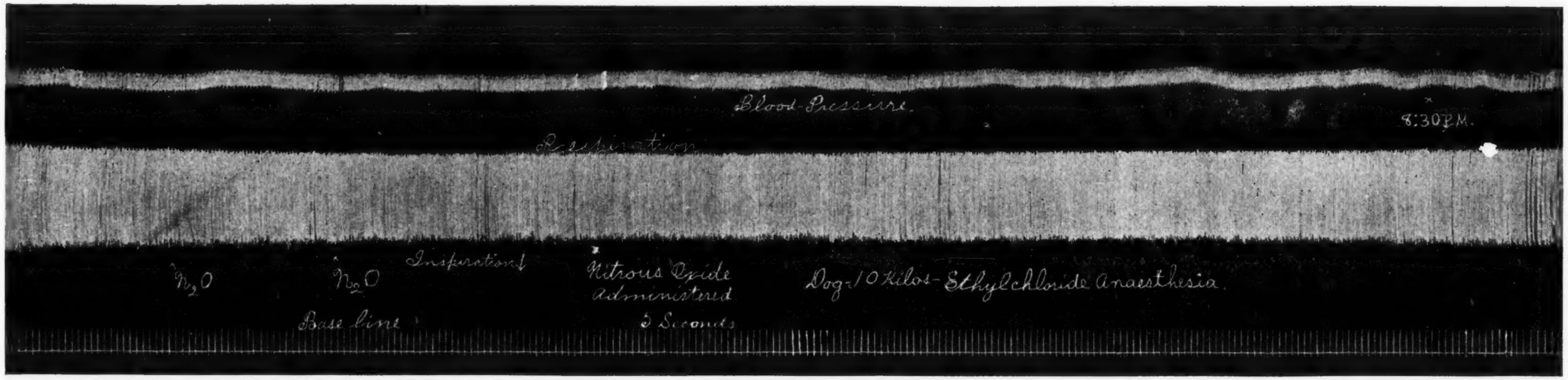

Fig 5.—Blood pressure and respiration in a dog anesthetized with ethyl chloride. At three places, as shown on the record, nitrous oxide was run into the breathing bag. This was done in order to observe the effects of the gas on the circulation and respiration. The results were practically nil so far as can be observed from the record.

conclude that it is impossible to obtain a rapid (1 minute) production of anesthesia and unconsciousness in dogs with nitrous oxide and oxygen at atmospheric pressure unless the oxygen content of the mixture is so low that the loss of consciousness is due *almost entirely* to the lack of oxygen. Presumably, with certain modifications, this is true in the human subject also. On the other hand it seems probable that in all dogs which do not possess a special idiosyncrasy against the gas, mixtures of nitrous oxide and oxygen containing sufficient amounts of the latter to avoid most if not all asphyxial effects, may be used to produce anesthesia *provided sufficient time be allowed for the gas to act and the CO_2 be completely removed as fast as it is excreted by the lungs.* If a high per cent of oxygen is used, anesthesia cannot be quickly produced but asphyxia may be avoided. The time required may be considerable, perhaps from five to fifteen

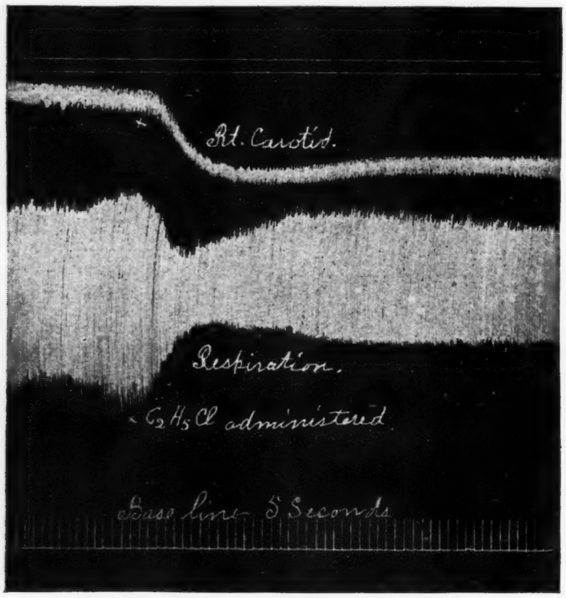

Fig. 6.—This animal was anesthetized with nitrous oxide. At the point indicated ethyl chloride was injected into the bag. There is an immediate fall in pressure and the respiration is much diminished.

minutes or longer. But as the tissues gradually become more and more saturated with the gas, there will be a gradual depression of the central nervous system which will finally result in unconsciousness.

It was long ago observed by Goldstein[9] that anesthesia appears more quickly and with a proportionately less degree of asphyxia, the higher the organization of the brain—namely, earlier in man than in laboratory animals. I have been able to confirm this observation many times. And in addition the anesthesia appears as a general rule to be deeper in man than in dogs, although in some animals a profound anesthesia may be readily obtained if all carbon dioxide effects be carefully avoided.

It seems probable that in average cases the heart and circulation are not much affected by the gas. Fig. 5 shows the result produced by injecting nitrous oxide into the breathing bag when the animal was already anesthetized by ethyl chloride. Three injections were made but the effects on both blood pressure and

respiration were practically nil. This corresponds very well to the injection of an ordinary drug solution into the femoral vein when an animal is anesthetized with ether. (Fig. 6 shows the reverse of this experiment and illustrates the action of ethyl chloride on an animal already anesthetized by nitrous oxide.) As a kind of check on these experiments another tracing (Fig. 7) is shown in which at two places a small amount of carbon dioxide was injected from a tank into the breathing bag. There is an immediate stimulation of the respiration and the blood pressure falls, probably from a direct action on the heart. The gas was quickly emptied out and the bag was again refilled with nitrous oxide plus a suitable amount of oxygen. This shows quite well the action of even small amounts of carbon dioxide. I strongly suspect that some such action as this, either by excess of carbon dioxide, or from lack of oxygen, or both, constitutes the real cause of the undesirable after effects which are liable to follow from pro-

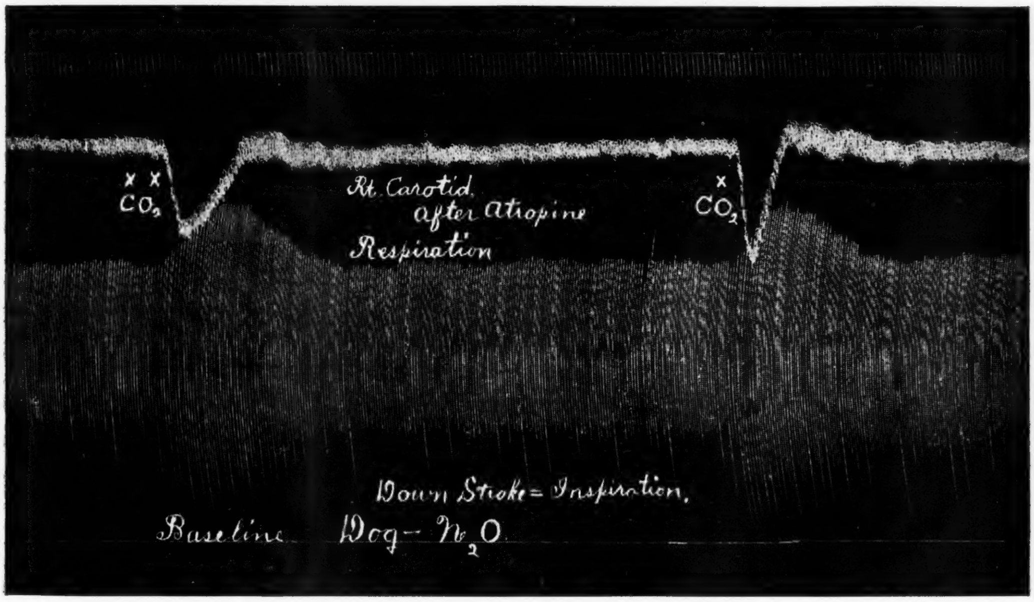

Fig. 7.—This tracing was made in a class experiment by Messrs. Mitchell, Day, Lueking and McKee. It shows the results produced on the respiration and blood pressure by injecting (twice) a small amount of carbon dioxide into the breathing bag while the dog was anesthetized by nitrous oxide. In each case the CO_2 was quickly emptied out of the bag after the animal began to show marked symptoms.

longed nitrous oxide anesthesia. And I am inclined to believe that these after effects may be very generally avoided by a correct and scientific administration of the nitrous oxide.

I have repeatedly observed, as have others, independently in my laboratory, that if one breathes a mixture of nitrous oxide and oxygen for a certain time, for example five minutes, and then passes under the influence of the gas to a given degree, he can then considerably increase the quantity of oxygen in the bag without lessening the influence of the nitrous oxide so far as the subject of the experiment himself can determine. The reason for this appears to be as follows: On breathing the N_2O at first the whole body of the subject after a time becomes saturated with the gas at the given partial pressure. (As the first portion of gas is absorbed, one can see the bag shrink fairly rapidly with ani-

mals.) More N_2O must be run into the bag to replace that absorbed. But after the anesthesia or analgesia has reached a given degree, then if no more gas, but only oxygen, is given, the effects of the N_2O on the subject should remain fairly constant. It will be noted that the gas is excreted only into the bag from which in a given time approximately the same quantity of N_2O will pass back again into the blood. Supposing the bag was filled to the amount of two gallons* with 90 per cent N_2O and 10 per cent oxygen. If then one adds a quart of oxygen to the bag the per cent of oxygen the patient would breathe should be increased by one-ninth of the total amount of mixed gases in the bag after the quart of oxygen is added. It would appear that this oxygen should be readily absorbed by the

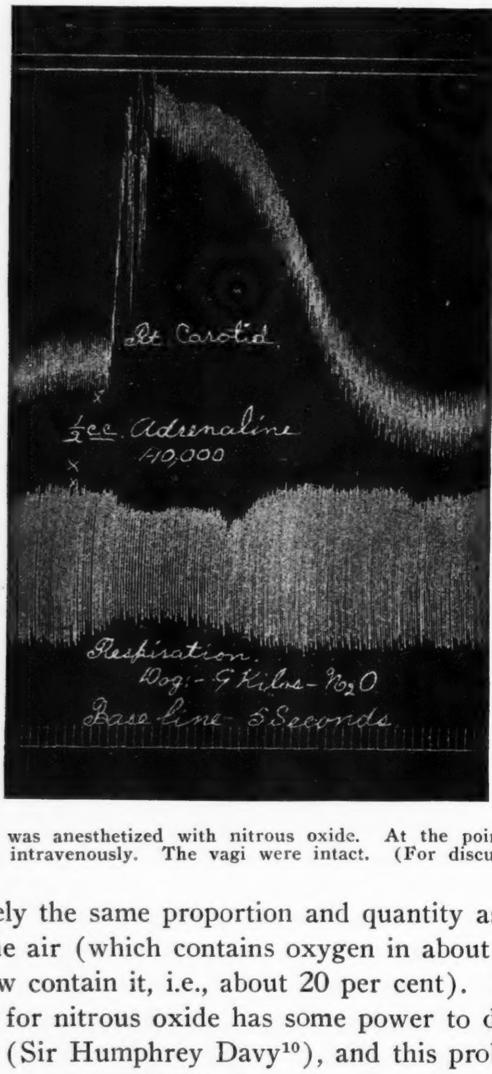

Fig. 8.—The animal was anesthetized with nitrous oxide. At the point indicated adrenaline (½ c.c., 1-10,000) was injected intravenously. The vagi were intact. (For discussion, see text.)

lungs in approximately the same proportion and quantity as oxygen is absorbed by the blood from the air (which contains oxygen in about the same proportion as the bag would now contain it, i.e., about 20 per cent). This would probably not be quite correct, for nitrous oxide has some power to displace oxygen from its solution in water (Sir Humphrey Davy[10]), and this probably holds good for the blood in the pulmonary capillaries also. On the other hand, when the quart of oxygen is run into the bag, the latter will be expanded by a volume equal to one quart and into this space the nitrous oxide already in the bag and also that dissolved in the blood and tissues of the subject, may diffuse. But if, for ex-

*For clearness of description I have assumed that the *volume* of one gallon of the gas may be considered equal to the volume of four quarts. We need not consider variations of temperature, pressure, etc.

ample, the blood and tissues of the subject had absorbed two gallons of N_2O and the bag contained two and one-fourth gallons of (mixed) gases after the quart of oxygen was added, then there would be a chance for the N_2O to be diluted by approximately one-seventeenth of the total volume of gases or 5.8 per cent. At that time the subject might be breathing almost 20 per cent of oxygen and this is readily absorbed by the hemoglobin of the blood. In other words, the relative increase in percentage of oxygen breathed when a given amount of oxygen is added to the bag, is greater than is the relative amount of dilution of the nitrous oxide with which the subject is saturated after the oxygen is added to the bag.

It was shown by Van Arsdale[11] in 1891 that the breathing of nitrous oxide

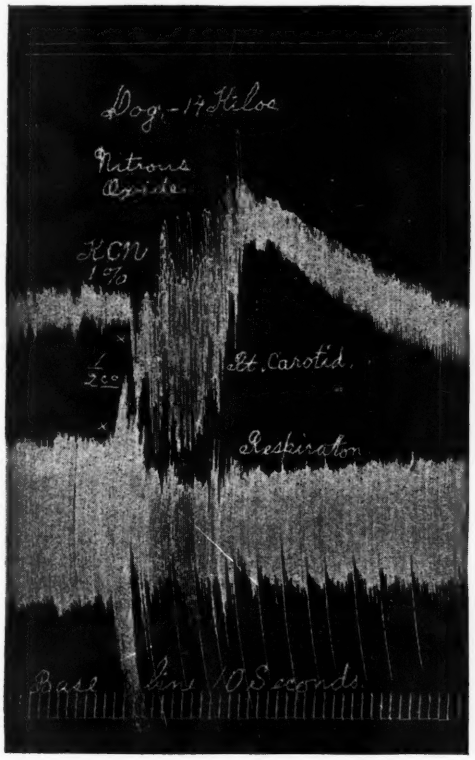

Fig. 9.—Dog anesthetized with nitrous oxide. At the point indicated ½ c.c. of 1% KCN was injected intravenously. The vagi were intact. (For discussion, see text.)

to and fro from a bag in which the gas (plus the desired amount of oxygen) was contained at an increased pressure above that of the atmosphere caused an increase in the depth of the narcosis produced. (This was an entirely different principle from that which Paul Bert[12] and later Claude Martin[13] used in which the patient or animal was placed in an air-tight room, the air pressure in which was raised one-fourth above that of the atmosphere after which 80% N_2O plus 20% oxygen was administered to the patient or animal.) I have tried to verify Van Arsdale's results many times. In some cases (with dogs) increasing the pressure of the gas in the bag does deepen the anesthesia, but in many other cases I have not been able to demonstrate any advantage from this increased pressure.

Perhaps the increased respiratory exertion, the marked hindrance to the pulmonary circulation and the attendant obstruction of gaseous exchange in the lungs were sufficient in many cases to overcome the advantages of the increase in absorption of the N_2O which the raised pressure might bring about.

The intravenous injection of adrenaline in an animal under nitrous oxide anesthesia gives a practically normal reaction, i.e., the record is almost exactly like that produced by adrenaline in an animal under ether. The rise in pressure here probably supplies more oxygen to the brain and whatever asphyxia may have been present from the administration of the nitrous oxide is thereby reduced. (See Fig. 8.) On the other hand, the injection of cyanides (which are supposed to cause an internal asphyxia by lessening the tissue oxidations through inhibiting ferment action) causes a markedly increased reaction both as regards the respiration and the circulation. The animal also shows a more marked convulsive reaction than it does under ether. (See Fig. 9.) I have controlled this

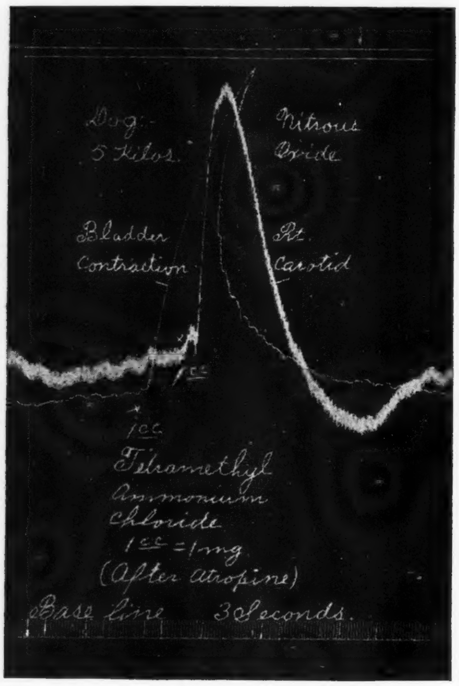

Fig. 10.—Dog anesthetized with nitrous oxide. The tracing shows the blood pressure (Rt. carotid) and the bladder contractions (up-stroke). At the point indicated 1 c.c. of tetramethylammoniumchloride was injected intravenously. The animal had previously received 1½ mgs. of atropine.

by anesthetizing the animal first with N_2O and obtaining records of the blood pressure and respiration from the cyanides and then giving the animal ether, after which more records were obtained.

The motor areas are much more sensitive under nitrous oxide than under ether. One can easily secure very extensive movements of the muscles of the opposite side and can readily pick out the areas for individual groups of muscles. I have observed that dogs under nitrous oxide anesthesia may not well withstand extensive operations, particularly if the abdomen is opened and the viscera manipulated in any way.

In several respects there is a striking similarity between the effects of nitrous

oxide and those of morphine in dogs. Among these may be mentioned the production of Cheyne-Stokes respiration. This is generally present in prolonged anesthesia in dogs. The irritability of the cord is also much less depressed than is the case with the methane series of anesthetics and this action also closely resembles that of morphine. As under morphine defecation also sometimes occurs, but I have generally been inclined to attribute this to asphyxia, although other factors may be involved. A peculiar feature is often noticed in the fact that the dogs, while lying quietly and apparently fairly well anesthetized, may be aroused and waked up by stimulation or shaking in a manner very similar to that possible under a moderate dose of morphine. When thus aroused there is also often observed a marked acceleration and increase in strength of the heart beat. If the animal be again left alone it will soon return into the somnolent, or perhaps analgesic state, very much as occurs after morphine. It is difficult to study the analgesic effect of nitrous oxide separately and apart from the pro-

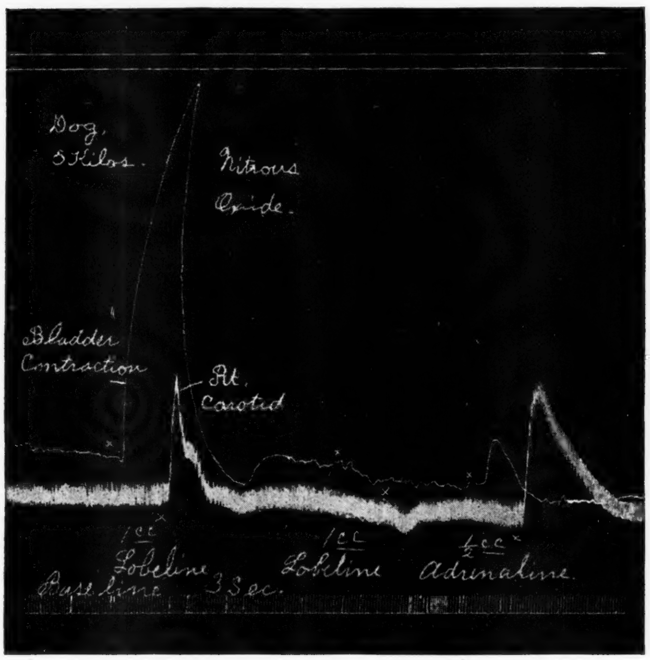

Fig. 11.—Dog under nitrous oxide anesthesia. Bladder contractions (up-stroke) and blood pressure. At the point indicated (on the left) 1 c.c. of lobeline was given intravenously. A marked contraction of the bladder and a small rise in blood pressure were produced. A little later a second dose of 1 c.c. of lobeline was given. Almost no results were produced by this, showing that the first dose of lobeline had produced ganglionic paralysis. Later a small dose (½ c.c.) of adrenaline was injected. This gave a slight bladder contraction and a small rise in blood pressure.

duction of total unconsciousness in dogs, for these animals, so long as they are conscious, are very likely to struggle and try to escape even though they feel no pain whatsoever.

The thought has occurred to me many times that nitrous oxide might be used as a hypnotic. By ordinary methods of administration this is obviously impractical. But by a slight modification of the apparatus which I have used I am inclined to believe this idea might be very well put into practice. I have tried repeatedly to compare the mild on-coming effects of the gas as breathed with a considerable proportion of oxygen with the physical and mental sensations pres-

ent as one begins to fall asleep. There is a very striking similarity, a marked feeling of tiredness and exhaustion, the limbs feel heavy and the eyelids tend to close. One's mentality gradually sinks and there is difficulty in maintaining connected thought. The natural inclination of the subject of the experiment is to lie down quietly and fall asleep. The sensations remind one of the feelings of a child worn out by a long day's play when it lies down at night to sleep. Sometimes I have noted slight muscular twitchings or feeble jumping or convulsive movements. These would probably not occur if the gas were administered very slowly with plenty of oxygen and a sufficiently long period of time were used to bring on the action of the drug. Suggestion appears to play a noticeable part in this action, for if one keeps perfectly quiet and at rest and tries to go to sleep, then the somnolent action of the gas is especially liable to be well marked. It would appear that this matter of suggestion extends even to dogs. For an animal which is petted and induced to lie down quietly and at complete rest may very often take the gas readily and peacefully fall asleep.

BIBLIOGRAPHY.

[1]Jackson, D. E.: Jour. Lab. and Clin. Med., 1916, i, p. 644.
[2]Jackson, D. E.: Jour. Lab. and Clin. Med., 1915, i, p. 1.
[3]Henderson, Yandell: Jour. Amer. Med. Assn., 1914, April 11, p. 1133.
Also Douglas, C. G.: Literature in the Ergebnisse der Physiologie, 1914, xiv, p. 338.
[4]Kemp, George: Brit. Med. Jour., 1897, ii, p. 1480.
[5]Hewitt, F. W.: "Anesthetics and Their Administration," London, 1912, p. 312.
[6]*See* Robinson, G. Canby: "Transient Auricular Fibrillation in a Healthy Man Following Hydrogen Sulphide Poisoning," Jour. Amer. Med. Assn., 1916, May 20, p. 1611.
See also Willett and Tyrrell (2 cases): The Lancet, London, 1902, March 29, p. 897. In both of these cases I suspect cardiac irregularities were present.
[7]Henderson, Yandell: Jour. Amer. Med. Assn., 1914, April 11, p. 1134.
[8]Haldane, J. S., and Poulton, E. P.: Jour. Physiology, 1908, xxxvii, p. 401.
[9]*See* Gwathney: "Anesthesia," New York, 1914, p. 127.
Brunn: "Die Allgemeinnarkose," Stuttgart, 1913, p. 327.
[10]Hewitt, Sir Frederic W.: "Anesthetics," London, 1912, p. 91.
[11]Van Arsdale, William Waldo: Amer. Jour. Med. Sc., 1891, cii, p. 142.
[12]Bert, Paul: Comptes rendus, 1879, lxxxvii, No. 20, p. 728. *Also* xcvi, p. 1271.
[13]Martin, Claude: Comptes rendus, 1888, cvi, p. 290. *Also* L'Union Médicale, 3 sér, 45, 1888.

THE HISTORY OF ORTHODONTIA

By Bernhard Wolf Weinberger, D.D.S., New York City.

(*Continued from page* 509.)

JOHN TOMES (1847) in *"Dental Physiology and Surgery"* illustrates "The Upper and Lower Jaws, with the *full complement* of finely developed teeth," and states:

"The reason for assuming that in these cases the permanent were kept back by the temporary teeth is, that the crown of the former is received between the fangs of the latter, and therefore cannot come through without the previous removal of the superimposed tooth. Again, irregularity in time seldom occurs to the same degree in any of the more anterior teeth, which, when the temporary teeth remain after the usual time for rejection, appear either anterior or posterior to them."

"Another cause of irregularity in the time of eruption of the adult teeth,

arises from insufficient space in the jaw, from defective growth. The canine teeth are retarded from this cause more frequently than any other teeth, arising from the canine being last to be cut, and the space being occupied by the incisors and bicuspids which have been previously evolved. I have seen several specimens of this—one on the table—in which the canine tooth, from want of space, has been developed, but remained deep in the jaw, completely imbedded in the bone, the crown resting between the fangs of the lateral incisor and the first bicuspids. Nature, in these cases, has fitted the teeth for their peculiar position by developing an extremely short fang."

"Today I shall bring to your notice the various deviations from the normal arrangement of the teeth. You have been told that the front teeth (by which I mean the incisor and canines) with the bicuspids, occupy in the well formed jaw a semi-circle, and that the molars extend backward from the two ends of the semi-circle, in slightly diverging lines; thus forming together an elliptic curve. In this curve the tooth projects before or recedes behind the neighboring teeth. Such is the normal arrangement of the perfectly developed teeth in well formed jaws. Instead, however, of the teeth presenting this even and uninterrupted line, we occasionally find that one or more teeth are placed either external or internal to the line, the teeth themselves being at the same time individually well formed. In the normal position each tooth has its anterior and posterior, or speaking more correctly, its buccal and lingual surfaces, placed at right angles to the radius of the curve which it contributes to form; but a tooth may be twisted on its axis, and have these surfaces, anteriorly and posteriorly, and thus constitute a form of abnormal position. Mr. Saunders in his lectures before referred to, speaks of a case in which a front tooth was twisted half way round, so that the proper lingual surface was anterior. In the normal arrangement, the anterior teeth of the upper close over in front of the corresponding teeth of the under jaw. In some cases, however, from malposition of the teeth, or from want of a proper ratio in the growth of the upper and lower jaw, the upper teeth close posterior to those of the lower jaw—a condition commonly denominated 'underhung.' "

"Instead of the under teeth closing anterior to the upper, we find in some instances that they close upon the cutting edges of the upper teeth, which constitutes another form of irregularity, though partaking of the same character as the preceding form."

"A third form of abnormal position occurs where the front teeth do not come together at all, a space of variable width separating them when the mouth is closed."

"The causes of abnormal position of the teeth are almost exclusively of a mechanical nature and may be divided into four classes. First, want of sufficient room in the alveolar arch for regular arrangement. Secondly, abnormal position during development, as regards the fangs of the preceding temporary teeth. Thirdly, non-absorption of the fangs of the milk teeth. Fourthly, a more rapid growth in the one jaw than in the other producing undue prominence of the teeth or abnormal development of the jaw."

"If malformation of the jaw be the cause there is but little hope of remedy; if the jaws are too small to admit of the natural arrangement of the teeth, but are

otherwise well formed, then we may by the judicious application of mechanical means, with which I shall presently make you acquainted, reduce the teeth to their normal position."

"*Treatment.*—When we see how much can be done by orthopædic surgery in restoring crooked and deformed limbs to the natural form, whether the patient be middle aged or young, we should at once conclude, even without the aid of experience, that much might be done to remedy irregularity in the arrangement of the teeth, and we should become more certain of our point when we observe that if the molar teeth from age or accident be lost, the under incisor, closing against the posterior inclined surfaces of the upper incisor, slowly but surely force the latter outwards."

"The treatment, then, mainly consists in applying steady uniform pressure upon the irregular tooth in the direction of the place you wish the tooth to occupy."

"What has been said of irregularity in the position of the front teeth applied generally to irregularity of the bicuspids, as also to the molars, though the latter are less frequently subject to the irregularities in position, and when it does oc-

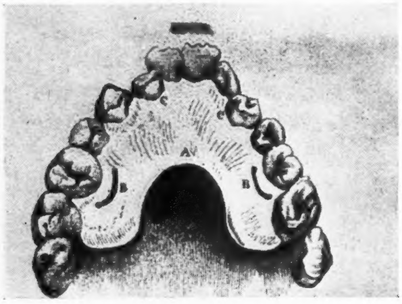

Fig. 1.

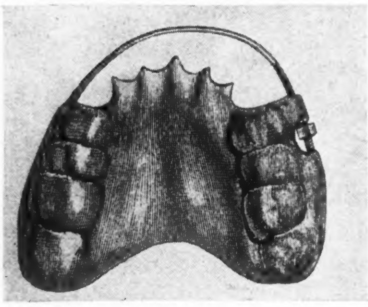

Fig. 2.

Fig. 1.—"A plate for a fixed point, from which to reduce to order irregular teeth, represented in situ." Made of ivory. (John Tomes. 1848.)

Fig. 2.—"Vulcanite plate for drawing inwards the front teeth; the thin elastic band of gold is tightened by means of the nut shown on the right of the figure." (John Tomes.)

cur, the degree is very slight, amounting, except in rare cases, to nothing more than the one standing a little out, and the next little in, thus forming a zigzag line."

Complete Irregularity in the Front Teeth.—"It can scarcely happen that we have irregularity in the teeth of one jaw without a corresponding irregularity in the teeth of the other jaw; the one following as a consequence of the other."

"The most common abnormal position occurs in these cases where the upper teeth, on closing the mouth, pass behind those of the under jaw."

"This form of malposition of the teeth may arise from several causes. Thus the under jaw and teeth may be developed more rapidly than the upper. The incisors of the under jaw usually appear before those of the upper jaw, and take their position internal to the temporary teeth, which at the time are usually loose and quickly fall out, and then the succeeding teeth come forward and occupy their places."

"A third cause of the posterior position of the front teeth of the upper jaw may arise in the permanent teeth of the under jaw, coming through anteriorly

to the temporary teeth, so that the upper teeth, closing behind them, tend to force them still further outwards."

"*Treatment.*—The causes of the reversal of the relative position of the front teeth of the two jaws you have seen is purely mechanical, and the defect is maintained by a mechanical cause. Our treatment must therefore be mechanical also. The first we have to do is to prevent the front teeth from closing and thus preventing them from exercising any influence upon each other. This is effected by placing caps of metal or ivory upon the masticating surface of the molars of the upper jaw, of such a thickness that when the mouth is closed the front teeth no longer meet. Having attained this point, a steady uniform pressure must be directed against the posterior surface of the misplaced teeth, and continued till, on removing the caps upon the molars the upper teeth are found to close in their position; the position having been once gained is retained by action of the under teeth upon the inclined posterior surfaces of the upper teeth."

"There are three methods of applying the pressure to force the teeth outwards. In one a fixed point is gained by fitting a piece of ivory to the hard palate and the surfaces of the necks of the teeth, to which it is tied so as to prevent the possibility of motion; pieces of dry compressed wood are then interposed between the ivory and the necks of the teeth you wish to be moved outwards. The wood on absorbing moisture swells and as the fitted ivory cannot be moved backwards the teeth are necessarily moved forwards; after the wood has remained about eight and forty hours it should be removed and a piece of fresh wood put in its place, which on swelling forces the teeth still further outwards. The renewal of the wood is repeated till th teeth have assumed the required position; the ivory is then removed from the palate and the caps from the teeth, and the process is allowed to be completed by the action of the upper and under teeth upon each other, the under forcing the upper outwards, and the upper pressing the under inwards till the molar comes in contact, when the front teeth assume their permanent place."

"In the second method the fixed point is made anterior to the teeth, and is accomplished in the following manner. Caps, as in the former case, are fixed to the molar teeth, from thence a strong piece of flattened gold or silver wire is made to pass in front of the teeth. Opposite each tooth the wire is perforated with one or two holes, through which a ligature of silk is passed round the neck of the tooth; the silk is then tied tightly to the wire. The teeth by the action of the silk are dragged outwards. The ligatures require to be tightened and removed from time to time till the teeth have assumed the required position, when the appartus is removed. Instead of silk, the vulcanized India-rubber is frequently used. The third method of treatment consists in fitting metal to the surface of the front teeth of the lower jaw. The plate is continued upwards above the edge of the teeth, but instead of proceeding in the same line, is turned inwards, so that on an attempt to close the mouth the piece of metal passes behind the teeth of the upper jaw, and presenting an inclined plane, forces them outwards."

"The success of the methods of treatment will be greatly enhanced by capping the molar teeth."

"Of the three forms of treatment, I have described to you I much prefer the

first, being more easy of application, more rapid in its effects, and less troublesome to the patient than the two succeeding methods."

"A second form of complete irregularity of front teeth is when the upper and lower close upon each other."

"The treatment necessary for the reduction of this irregularity is precisely similar to that required in the treatment of the 'under lining.'"

"However, in these cases, if attention is directed to the subject early, the simple pressure by the thumbs of the upper teeth outwards, will, in many cases, with a little care and perseverance, place the teeth in their proper relative position, especially if frequent attempts be made to place the under teeth in drawing back the teeth of the under jaw behind those of the upper jaw."

"A third malposition of the front teeth occurs in an excessive prominence of the upper set. The front teeth press into the lips, are constantly exposed, and when the mouth is closed rest upon the under lip. This form of irregularity is more or less connected with the defective development of the superior maxilla. The alveolar process is developed at a considerable angle with the general surface of the face, and the edge embracing the necks of the teeth is therefore very prominent. This prominence might arise from several causes. Thus the permanent teeth might come down in front instead of behind the temporary teeth and their alveoli, and supposing the milk teeth to be presented a little beyond the usual period would at once tend to the deformity in question."

"Again, if the incisors are long, and the molar teeth short, the under incisors on the mouth being closed, will, instead of resting upon the basal edge of the upper teeth, press down the inclination of the ridge and finally get fairly behind the teeth, and with their edges against the surface of the gums. We often see this state produced when, from age or some other cause the molars and bicuspids are lost.

"*Treatment.*—The first thing to be done towards remedying this evil is to remove one or two bicuspid teeth, so that space may be gained for bringing the teeth inward, which may then be effected by pressure inward, the fixed point being either external to the teeth in the form of a band of metal, or internal to the teeth in the form of a piece of ivory fitted to the palate."

"There is a fourth form of complete irregularity of the front teeth. The alveolar lines of the jaws are developed at such an angle with each other that on closing the mouth, the molar teeth alone come in contact, the front teeth being separated to a considerable interval. If the defect in formation be discovered early in life, some attempt at restoration should be made by continued pressure under the chin, but if the deformity is found in the adult, the less you interfere the better, as your patient will have overcome by habit the inconveniences arising from malformation."

"Whichever of the anterior teeth be the subject of malposition the same modes of treatment for the reduction of the irregularity are applicable. If, then, the front teeth are found, on examining the gums, to be out of position the cause of the irregularity should be sought."

"If there is a want of space, one or more of the temporary teeth should be removed, and the patient should be directed to press the tooth frequently during the day towards the proper situation. The required position may, in some

cases where the irregularity is slight, be given the new tooth by the frequent use of a piece of wood shaped something like the handle of a spoon. The bent part should be passed behind the inward tooth, and the mouth partially closed, when the projecting portion of the instrument should be pressed downwards towards the chin. The under teeth will then form the fulcrum, and the upper tooth will be moved outwards. If the under teeth stand too much inwards the action of the lever may be reversed, and the upper teeth made the fulcrum."

"Our first step in the treatment must, therefore, be to remove the influence of the opposing teeth by placing caps on the molars, which will so heighten them that on closing the mouth the front teeth do not come in contact."

"Having accomplished this point, and ascertained that there is sufficient space in the proper situation, steady pressure must be made upon the irregular teeth. If one tooth only be displaced it may be sufficient to pass an elastic ligature behind or before (as the case may require) the irregular tooth, and then round the adjoining teeth, in such a manner that the ligature shall exercise a

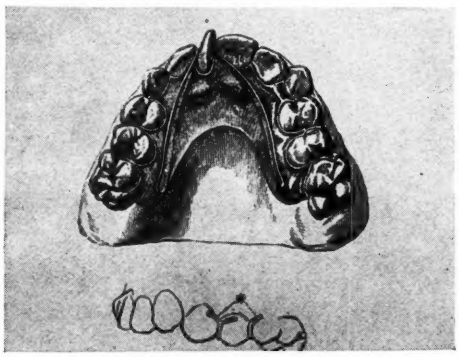

Fig. 3.—Metal plate with two elastic bands of gold soldered to the back part of the plate, the free ends pressing upon the teeth. In the sketch below, the manner of adjusting the wire bands for the retention of the plate is shown.

tractile force upon the tooth in the direction in which it should move. The best material for elastic ligatures is vulcanized caoutchouc."

"If, however, the irregular teeth are well grown, the treatment by elastic ligatures may occupy in inconvenient time, and it will be better at once to construct a plate fitting the palate, and thus gain a fixed point."

J. B. Mitchell, in his paper on the *"Management of Irregular Dentition,"* published in 1847 in the *"American Journal of Dental Science,"* has the following to say:

"Irregularity of the second dentition, viewed in regard to its cause is of two kinds; the one arising from a want of harmony between the development of the permanent set, and the decadence of the milk teeth, the other depnding on a defect in the correspondence which ought to exist between the growth of the jaws and the increased volume of the second series of teeth."

"That species of irregular dentition, however, which depends on the disproportion between the capacity of the jaws and the size of the teeth, forms the subject of several conflicting opinions. Two principal views have been taken by dentists, the distinguishing features of which are, on the one side, a tendency

to allow things to take their course until remedial measures are called for, and, on the other, a leaning to preventive means."

"In the system which is based on the former view, reliance is almost exclusively placed on the natural expansion of the jaws during the second dentition—no decisive measure being adopted till after that period has elapsed, when, if room cannot be provided in the dental arch for the irregular teeth, by artificial means, they must be extracted."

"The fundamental errors of this system are its temporizing nature and the sacrifices that are entailed by the delaying of the treatment. In the first species

Fig. 4.

of irregularity, this delay is rather to be commended than condemned, but, in that kind of irregularity which arises from disproportion between the size of the teeth and the development of the jaws, I should consider the sacrificing of one of the permanent incisors or canine teeth as little better than no treatment at all, or at least not such as one would expect from the superintendence of a professional man."

W. Rogers, in 1847, following Robinson. He declared that he was very much against ligatures. He also condemned the use of plates, level planes, rods, pivots, hooks or hinges. He asserted that there are no defects in regulation which could not be done away with, so long as the patient is still young; he even says that many cases come about successfully at the age of thirty.

For his own method of regulation, he procured the necessary room for the

teeth, first, by filling the sides of the teeth to be regulated; second, by widening the arches of the alveoli; and third, by extracting either one or both small back teeth of the jaw bone. He recommended the latter procedure, for he believed that the teeth become straightened almost by themselves. For material for apparatus he used only gold, for it possesses more elasticity than all other metals; for ligatures he used silk.

For the treatment of irregularity he made use of his own "Regulator" which

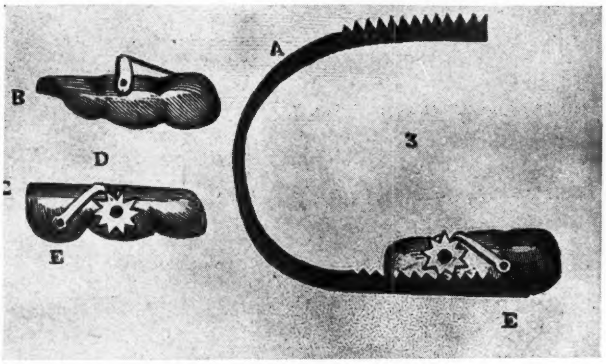

Fig. 5.—Type of appliance as used by Wm. Rogers. 1845.

he claims is simple, good-looking and effective in all cases. It consisted of three distinct parts. The first part was indented on both sides, semi-circle in shape and joined together by two metal shells, which were fastened upon both molars and served as a fulcrum. The indented part fitted in the shells by means of a

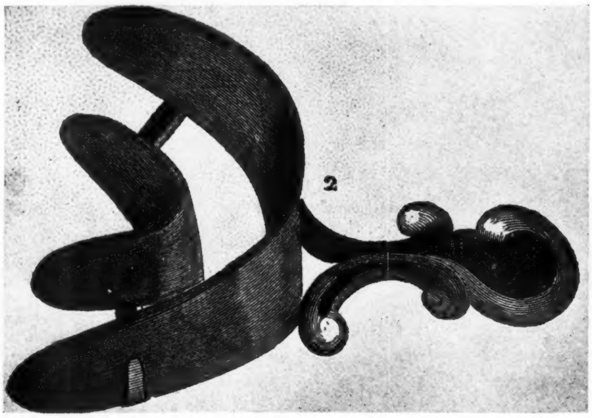

Fig. 6.—Form of one of the impression trays used by Wm. Rogers.

shell, which turned around by means of a watch-key, and which was fastened with a thread hook.

S. P. Hulihen, American Journal of Dental Science (1849), was perhaps the first to advocate a surgical procedure in extreme cases of protrusion of the mandible. This idea was later suggested by Ottolengui (*Dental Cosmos,* 1897, p. 143); by Whipple (*Dental Cosmos,* 1898, p. 552); and by Angle (*Dental Cosmos,* 1898, p. 635). Owing to the age and the extreme protrusion of the jaw, it was decided that the ordinary method of procedure for its correction

would not be effective, and that a surgical operation should be resorted to,—the removal of a section of bone from the body of the jaw and alveolar process in the bicuspid region on each side of the arch.

"To remove the projection of the under jaw seemed to require the first attention. Unless that could be done, the other operations, however successful, would add but little if any to the personal appearance of the patient. This lengthening of the jaw had taken place entirely between the cuspidatus and first bicuspid tooth of the right side, and between the first and second bicuspids of the left. By this elongation, the teeth just described were separated on both sides about three-fourths of an inch. To saw out the upper edge of these elongated portions of the jaw, and then to divide that part of the jaw in front of the spaces thus made, by sawing it through in a horizontal manner, so as to permit the upper and detached portion to be set back in its proper and original position, appeared to be the only possible way of remedying the deformity. This plan I therefore adopted, and performed the operation on the 12th day of June, in the manner now to be described."

"The operation was commenced by sawing out, in a V-shape, the elongated portions, together with the first bicuspid on the left side, each section extending about three-fourths of the way through the jaw. I then introduced a bistoury at the lower point of the space from which the section was removed on the right side, and pushed it through the soft parts, close to and in front of the jaw, until it came out at the lower point of the space on the left side. The bistoury was then withdrawn, and a slender saw introduced in the same place, and the upper three-fourths of the jaw, containing the six front teeth, was sawed off on a horizontal line ending at the bottom of the spaces before mentioned, the detached portions being still connected, on the outer and inner sides, to the jaw below, by the soft parts. After having, with the bone-nippers, removed from the detached portion the corners which were created by the horizontal and perpendicular cuts of the same, it was set back so that the edges, from which the V-shaped sections were removed, came together."

E. G. Tucker (*American Journal of Dental Science,* 1850) soon after the introduction of elastic rubber, conceived the idea of using the resistance of same for moving teeth. Although elastic rubber had been used prior to his time, he decided to make use of it in the form of tubing, cut into thin pieces, as rubber bands.

"To prevent disease is far more important than to cure it, both on the score of expense and comfort. This is, perhaps, a truth more applicable to our profession than any other."

"The removal of a tooth in the child may secure regularity, prevent premature decay, and thus ward off the pain and destruction that is sure to visit the adult tooth."

"Parents, therefore, cannot begin too soon to watch the growth of their children's teeth, and to seek the aid of the dentist. They should realize that this advice is not given for the purpose of increasing the labors of the dentist, but to lessen them. If he does more for the girl, he will be called upon to do less for the lady, and if he performs his duty to the boy, there may be no occasion for calling him to the man."

"The business of regulating teeth is new to most people, and yet, when we consider to what expense some are willing to go for comfort, convenience and appearance, it must become, in time, a very important branch of our profession."

"I have been led to suppose that something might be contrived as a substitute for spiral springs, gold bands, etc. I have made, for experience, rubber tubes of different sizes and thicknesses, so that rings may be cut of any dimensions. No substance that I can think of would be more likely to prove pleasant to the mouth, or less likely to irritate the tender parts; besides, by these tubes, we may have a great variety of means, as to power, in the simplest and cheapest form. We can commence with a small force and increase, or reverse the operation, according to the circumstances of the case."

"The frame-work, made of silver or gold, may be prepared with hooks or clasps at different parts of the plate, so as to attend the loops with ease, by the use of two instruments, such as pluggers, stretching from tooth to tooth, whether near or remote. It is easy to conceive of a variety of operations with these pulling rings, and to you it is quite unnecessary to enlarge."

Dr. Wm. Dwinelle (1849). The jack-screw for the correction of irregularities of the teeth is thought to have been introduced by Dr. William Dwinelle about the year 1849. He first made it of gold, but later used steel on account of its greater strength. He discovered that by placing a small amount of zinc in a hole in the end of the screw device its oxidation was prevented.

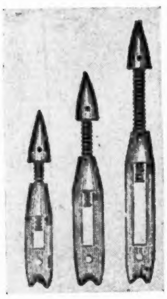

Fig. 7.
The jack-screw.
Wm. H. Dwinelle.

It seems strange that so important an appliance as the jack-screw should have been brought to the attention of the profession on both sides of the Atlantic during the same year. Who deserves the credit will never be settled, but to both Drs. Dwinelle and Gaines, of London, honor must be given for the above appliance. In *Johnston's "Dental Miscellany"* for 1877, we find the statement where he claims priority to the use of this method.

"Hitherto most of the instruments used by our profession for regulating teeth, of necessity, were composed of the superior metals, such as gold, platinum or silver; they being so soft in their quality, to make them strong enough to resist the force required for all practical use involved their being made so large and clumsy that they usually defeated their purpose, or compelled us to be satisfied with only a partial success. Here, then, was an opportunity to construct the smallest as well as most powerful instrument of steel, to be placed in the mouth with impunity. You had only to drill a hole in the steel and plug it with zinc, to give it the same immunity from oxidation as gold or platinum. A moment's reflection selected the jack-screw as the most powerful instrument, in proportion to its size, known in mechanics. Within a few hours I had a number of them made, from a quarter to over an inch in length, with various terminating points or ends, and with interchanging screws and nuts, some of which I have in use to this day, and all of which have ever been free from rust. It is only necessary to replenish the zinc, as it wastes away by oxidation, to keep them in order and ensure them from rust."

DEPARTMENT OF
DENTAL AND ORAL RADIOGRAPHY

JAMES DAVID MCCOY, D.D.S., EDITOR,
LOS ANGELES, CALIF.

A CONSIDERATION OF SOME OF THE FACTORS INVOLVED IN THE INTERPRETATION OF DENTAL AND ORAL RADIOGRAPHS*

BY JAMES DAVID MCCOY, D.D.S.,
Professor of Orthodontia and Radiography, College of Dentistry, University of Southern California.

NOT infrequently we hear the assertion made by members of the dental profession that only minor importance should be attached to the findings of the x-ray, their claim being that the radiograph can be construed as showing almost anything whether the condition actually exists or not.

Such an attitude can be explained as being the outgrowth of several things, among which a lack of knowledge of the fundamental principles of radiography and its various branches, and especially of the science of interpretation, stands as an important factor. Therefore opinions of the x-ray and its application in dentistry expressed by those unqualified, should not be regarded seriously.

The idea also seems to prevail among the dental profession that the interpretation of radiographs is an extremely simple matter, requiring little if any preparation on the part of the one who is to make the interpretation. This erroneous idea is doubtless responsible not only for many errors being committed, but also for a lack of greater appreciation by the profession of the value of the radiograph.

The first requisite of interpretation is an accurate knowledge of the anatomy and physiology of the structures involved, for a radiograph is a shadow picture, and a shadow picture is meaningless unless one is thoroughly familiar with the main characteristics of the original.

The radiograph may be said to vary from an ordinary shadow picture, as in addition to mere outlines, varying densities are shown due to the fact that the x-ray penetrates all matter in inverse ratio to its mass or density.

If one is possessed of an accurate knowledge of the anatomy and physiology of the dental and oral structures, the next step toward acquiring the ability to correctly interpret radiographs of these structures, would be *to become familiar with their radiographic appearance under normal conditions,* for unless one be familiar with the appearance in the radiograph of the structures under normal

*Read before the Southern California Dental Association, June 20, 1916.

conditions, it would be obviously impossible to intelligently recognize pathological or anomalous conditions unless they were of a glaring nature.

When we speak of the radiographic appearance of the structures under normal conditions, we refer not only to a freedom from pathological or anomalous involvement, but also to the character of the radiograph itself, which must be normal in that *it must be made in accordance with a technic, which results in the shadows of the structures under scrutiny being imposed upon the plate or film in their correct proportions.*

Therefore, it is essential that in addition to the before mentioned requisites, *one who would intelligently interpret radiographs must understand enough of the fundamental rules of radiographic technic to know when examining a radiograph, whether or not the technic involved in its making was correct or faulty, and if faulty, whether or not the degree of fault is sufficient to render it so inaccurate as to be useless.*

In correctly made radiographs, the dental and oral structures under normal conditions have a characteristic appearance, for owing to the varying densities

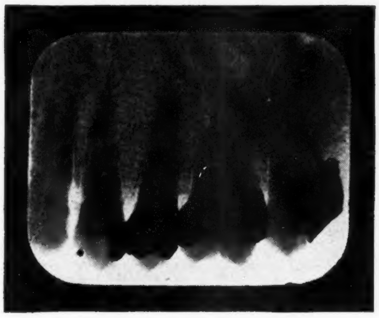

Fig. 1-*A*.

Fig. 1-*B*.

Fig. 1.—The radiographic appearance of the teeth and their surrounding structures under normal conditions are here shown. *A*. Upper bicuspids and molars. *B*. Lower molars. The color spectacle is, of course, reversed from what it would be if the original radiograph was under observation.

of the contained structures in our field, they appear upon the plate or film in a manner most advantageous for observation. For instance, it will be noted upon the examination of such a radiograph, that metallic fillings if they are present, appear as white masses, and root fillings as somewhat less dense lines. The enamel and dentine are next in density, while root canals show plainly as dark channels in the dentine, and the alveolar process and maxillæ show their fine uniform cancellous structures in various degrees of density, depending upon their thickness. (See Fig. 1.)

In examining a radiograph, it is essential that the original plate or film only be used, and this should be examined carefully and in a proper light, if the maximum amount of information is to be obtained from it.

This is best accomplished by utilizing some sort of illuminating box or cabinet from which varied degrees of light are obtainable. The face of such a cabinet should be covered with ground glass, so that the light transmitted will be equally distributed and free from shadows. As a radiograph is a transparency, a dim light behind it will bring out one set of shadows to their greatest clear-

ness. An increase in the light will show forth still other effects; while a high degree of illumination will bring out the more dense portions.

In this manner each portion of the radiograph may be studied under a degree of light destined to bring out the maximum amount of detail.

Now with a "print" or "lantern slide" one can study the field only from a one light aspect and oftentimes in order to secure any detail in the lighter or less dense areas, it will be found that the dense areas must be printed almost to an inky blackness. This fact accounts for the unsatisfactory appearance of many radiographs used as illustrations in our journals, for when reduced to half tone engravings much of their valuable detail is lost.

Fig. 2.—A cuspid tooth lying against the anterior wall of the antrum. It will be noted that the cuspid is inverted in its position.

If one be unfamiliar with the fundamental rules of radiographic technic, they cannot know when examining a radiograph just what portions of it are to be relied upon to give dependable information, for as a rule, owing to the anatomic arrangement of the structures in our field, only limited areas can be relied upon to be "in focus" in each radiograph. But if one is possessed of an accurate knowledge of the anatomy and physiology of the parts involved, understands the fundamental rules of radiographic technic, and is familiar with the appearance in the radiograph of the dental and oral structures under normal conditions, *it should by no means be difficult to see any alterations or changes, which occur in these structures as a result of anomalous or pathological conditions.*

The mere ability to note *an alteration or change* in the structures does not fulfill the requirements of intelligent interpretation, for *these alterations or changes* can have their full significance only to one *who understands the pathological conditions which may develop in these structures, and the character of the anatomical changes which they bring about.* Therefore, it should be apparent that the ability to intelligently interpret radiographs is not a thing to be acquired over night, but must come as the result of study in several important branches, and any one who attempts it otherwise assumes responsibilities unworthily.

Assuming that you are familiar with the appearance in the radiograph of the dental structure under normal conditions, let us consider some of the changes to be found in the presence of anomalous and pathological conditions.

Fig. 3.—The presence in or absence from the jaws of successors of the deciduous teeth can easily be determined, as well as the state of development of any unerupted teeth.

As a tooth is much more dense than the bony structures of the jaw or adjacent parts, any anomaly of form, size, or position, is easily discernible even though it occupy a position far from what might be expected; as for instance, in the case of impacted molars, teeth in the antrum, etc. (See Fig. 2.)

Likewise, and for the same reason, the presence in or absence from the jaws of successors of the deciduous teeth can easily be determined, as well as the state of development of any unerupted tooth. (Figs. 3 and 4.)

Fractured roots or fractures of the bone even without displacement, are often discernible at the line of fracture, owing to the fact that the line of fracture offers less resistance to the penetration of the rays, and therefore is apparent upon the plate as a dark line.

In examining radiographs, we should bear in mind the fact that very dense tissues are characterized by white areas, while less dense tissues appear darker, and the absence of tissue is indicated by blackness. To avoid confusion, we should remember that in prints and lantern slides, this color spectacle is reversed.

One of the most characteristic alterations or changes in the tissues to be noted in the radiograph, is that to be found where an alveolar abscess is present. We know that when such an abscess takes place there is always an accompanying destruction of the cancellous bone tissue at the immediate seat of the inflammatory process. Knowing that the absence of tissue is indicated in the radiograph by

Fig. 4.—An unerupted upper cuspid lying in contact with the root of the central. An attachment has been secured to the cuspid and it is being moved down.

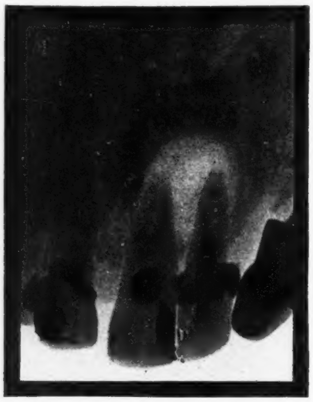

Fig. 5.—The characteristic appearance of a large alveolar abscess is here shown.

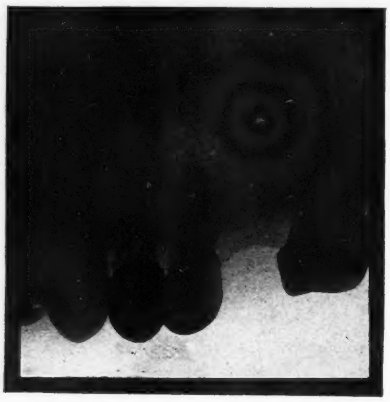

Fig. 6.—A large abscess is shown at the apex of the upper second bicuspid. Likewise upon close examination, an abscess is also shown at the apex of the first bicuspid. Notwithstanding the fact that this one is small, it should be regarded with the same concern as the large one.

a dark or black area, such an area if located at the apex of a devitalized tooth, or about a root or fragment of a root, would indicate the presence of an alveolar abscess. In fact, where these dark areas are found in the alveolar process, *and are not natural cavities,* such as the antrii, or the nasal cavities, or such well defined nerve openings as the mental foramina, and where they are *markedly* circumscribed, that is, having a distinct and abrupt line of demarcation between the dark area and its surrounding tissue, we can in nearly every case, even if a clinical history be lacking, make the positive diagnosis of alveolar abscess. (See Fig. 5.)

Not infrequently, dentists are prone to disregard such evidence, as these areas are often to be found about the apecies of teeth giving no inflammatory symptoms. However, in the light of our present knowledge of these conditions, we know that this fact no longer carries weight, nor is it worthy of special consideration. The fact remains, as indicated in the radiograph, that a change has taken place in the structures, and such changes occur only as a result of the presence of an inflammatory process. (Fig. 6.) Furthermore, it has been demonstrated that when such inflammatory processes are really eliminated, the cancellous tissues involved will again regain their normal character. (See Fig. 7—A, B, C.)

Alveolar abscesses do not by any means present a "stereotyped" appearance in the radiograph, but vary greatly in size. For this reason, the smaller ones may sometimes be overlooked, or not be regarded seriously by those lacking the requisites of intelligent interpretation. Likewise, these small abscesses

A

B *C*

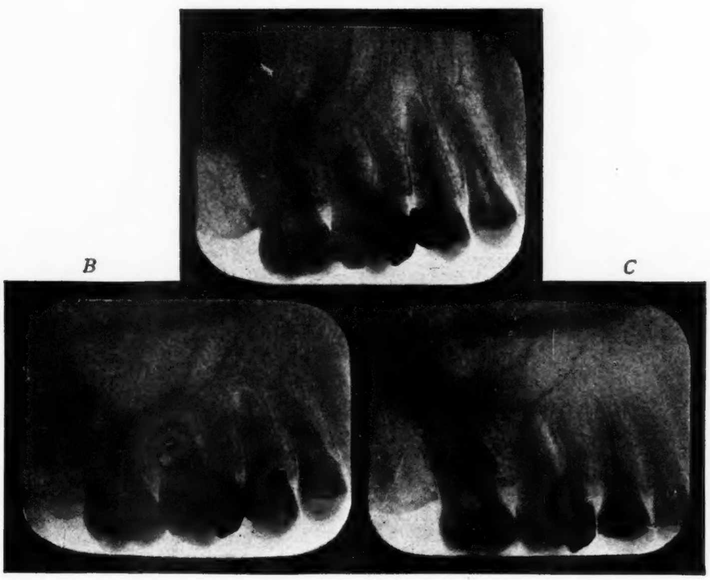

Fig. 7.—*A*, An upper bicuspid tooth with an alveolar abscess at its root apex. It will be noted that the root canal is incompletely filled.

B, The same tooth about two months after it had been treated and the root canal properly filled. The rarefied area about the apex has greatly decreased in size.

C, Shows the same tooth about six weeks later. The rarefied area has entirely disappeared and the bone structure about the apex appears to be normal.

may sometimes not be apparent in the radiograph as a result of the employment of incorrect technic in the exposure of the plate or film. (Fig. 8.)

Necrosis likewise appears upon the plate as a dark area, but differs in a characteristic way from the ordinary alveolar abscess in that it is not circumscribed, *namely, that there is not a distinct and abrupt line of demarcation between the dark area and its surrounding tissue*, as is the case with the circumscribed infections, but *the area gradually shades off from dark into light*, portraying the progressive characteristics of this disease. (See Fig. 9.)

The different filling materials vary but little in relative graduation of density, and when used as root filling materials, are plainly visible as light lines. Because they differ in density from cementum and dentine, the extent to which

they have been introduced into the root canals is easily discernible. (See Fig. 7, A, B, C.) Broken-off broaches and other instruments, or small wires introduced into root canals to determine their length or the extent to which they have been opened, because of their great density, appear very white and are easily differentiated from root-canal fillings or tooth structure.

Fig. 8.—Small abscesses are shown at the apexes of two upper bicuspid teeth. If in making this radiograph the images of the teeth had been lengthened as the result of incorrect technic, these areas would not be discernible.

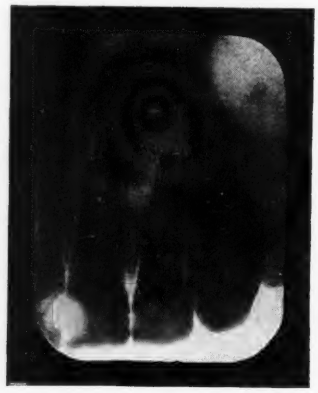

Fig. 9.—A necrotic area about roots of an upper central and lateral.

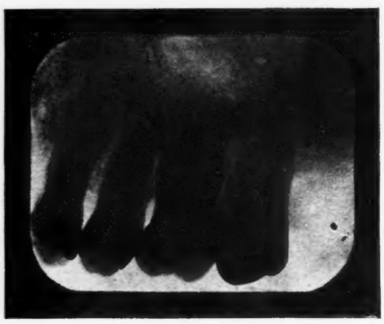

Fig. 10.—Characteristic appearance of the enveloping tissue about the upper bicuspids and molars in a well developed case of pyorrhea alveolaris. Compare the condition shown here with that shown in Fig. 1, *A* and *B*.

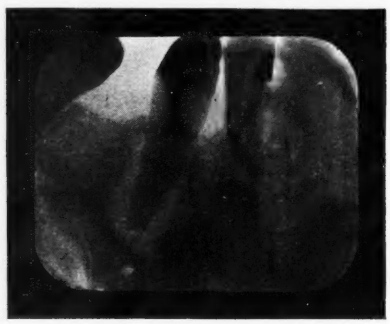

Fig. 11.—A destructive process in progress about a lower first bicuspid.

Fig. 12.—A hypercementosis is shown at the apical third of an upper lateral incisor. Also a deep pocket extending up the mesial side of the root terminating in an abscess area. Notwithstanding the fact that this condition had been present for months, the lateral was still vital at the time the radiograph was made.

Where a destructive process has ensued in the peridental membrane, or in the bony wall of the alveolus (pyorrhea pockets) and is present on the mesial or distal side of a tooth, these conditions appear upon the plate as dark areas owing to the fact that the rays pass through them more easily, and effect the emulsion of the plate to a greater degree than if normal bone structure is present. The approximate extent of the destructive process is therefore easily determined. (Figs. 10, 11, 12.)

Cysts and tumors of the maxilla or mandible, owing to the fact that the

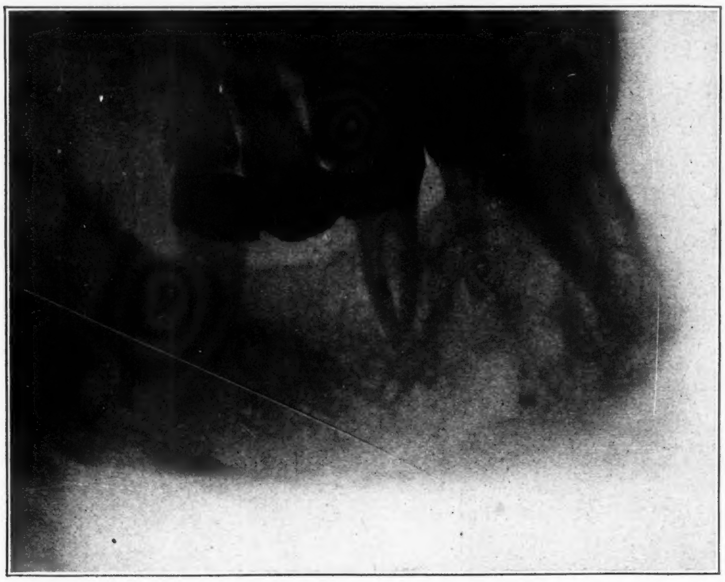

Fig. 13.—An osteo-sarcoma of the mandible.

character of the changes they bring about renders the areas involved less dense, their extent is visible upon the plate as a dark area. (Fig. 13.)

In seeking out the various anomalies and pathological conditions to which the teeth and oral structures are subject, *we should not be misled by indefinite shadows upon the x-ray plates.* The very nature of these structures, their gross as well as minute anatomy, renders them somewhat difficult to radiograph, and necessitates a refinement of technic greater than that demanded with most of the other portions of the human anatomy. *Therefore, only radiographs made in accordance with a definite and exacting technic should be relied upon for diagnosis. If a doubt exists in any given instance, an additional or even several more exposures should be made, so that any conclusions reached will be founded upon definite evidence.*

SOME INSTANCES IN THE PRACTICE OF ORAL SURGERY WHERE THE X-RAY HAS BEEN OF GREAT VALUE

By Emil Francis Tholen, D.D.S., M.D., Los Angeles, Calif.

Associate Professor of Oral Surgery, College of Dentistry, University of Southern California.

THE time has arrived when the x-ray is essential for good scientific work in oral surgery. This means that every one of us is obliged to know the interpretation of radiographs. While it is true that many radiographs give negative findings, yet this is often of valuable aid in arriving at a diagnosis by exclusion. However, we have our greatest aid in cases where the radiograph confirms and clears our physical findings. So much valuable aid has been derived that I wish to report a few cases with illustrations.

Miss C. 20 years. Displaced unerupted cuspid which is crowding lateral and central out of line. Deciduous cuspid in place. (See Fig. 1.) Refuses operation.

Mr. M. For six years was troubled with a chronic infection and fistula of the right upper jaw with frequent acute exacerbations. Had curetment and an

Fig. 1.

Fig. 2.

extraction without result. Radiographs showed extensive necrosis. (See Fig. 2.) It extended from the right upper central to the first molar and involved the right nares. The area was exposed from the canine fossa and thoroughly curetted. Recovered.

Mrs. L. Pain and cramping sensation in right side of face for four years. The only etiological factor was a piece of root surrounded by very dense bone and located just above the right mental foramen. (See Fig. 3-A.) I had to take repeated films in order to locate and remove it. (See Figs. 3, B and C.) Last report showed patient to be much improved.

Miss R. Fractured right upper lateral eighteen years ago. Had curetment and first root amputation during this interval without improvement. Examination and x-ray show a cyst over the left lateral containing gutta-percha.

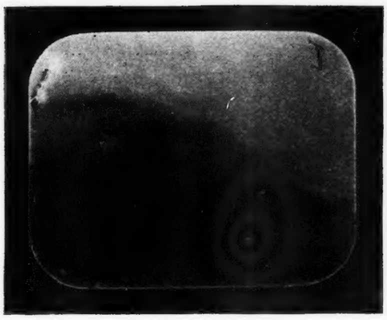

Fig. 3-A.

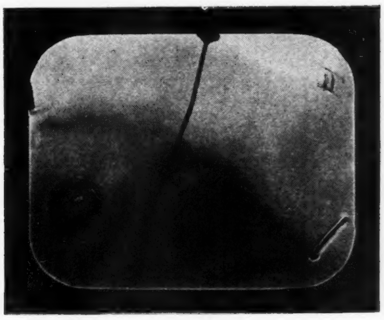

Fig. 3-B.

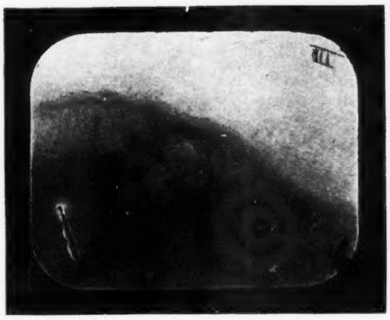

Fig. 3-C.

Fig. 4.

Fig. 5.

Fig. 6.

(See Fig. 4.) A re-amputation of the root was done and cyst wall entirely removed. Complete recovery.

Mrs. T. Case of chronic apical abscess. (See Fig. 5.) Root amputation. Radiograph two months after root amputation. (See Fig. 6.)

Mrs. K. Neuralgia pains and soreness of left upper jaw, lasting two years. Had various teeth extracted and antrum treated without relief. Antrum exploration was negative. Radiograph showed a piece of broach in root canal.

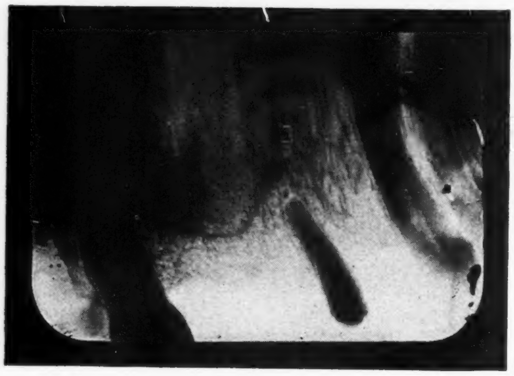

Fig. 7.

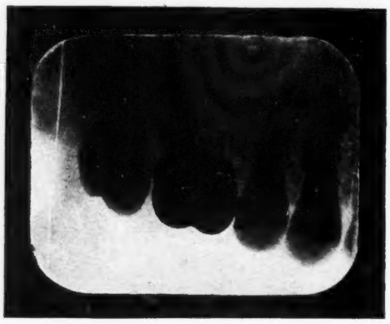

Fig. 8.

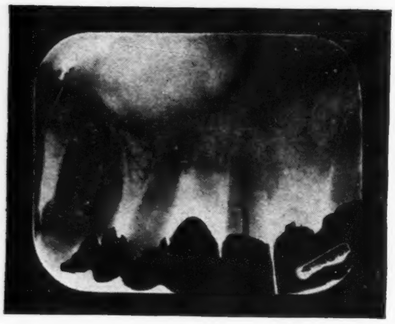

Fig. 9.

Fig. 10.

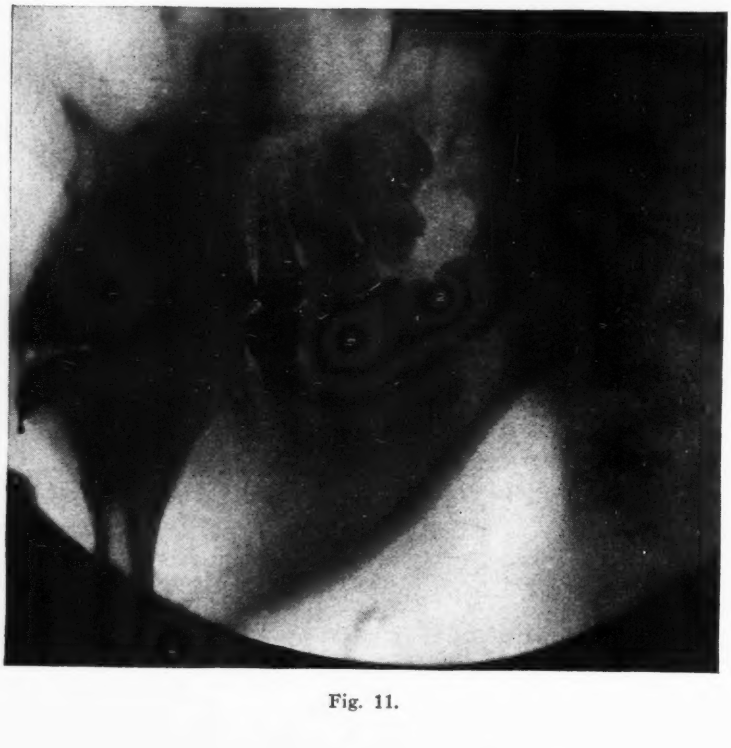

Fig. 11.

(See Fig. 7.) I was unable to remove the broach, therefore extracted tooth and curetted. Complete recovery.

Mrs. E. History. Symptoms of left antrum disease for three years. Radiograph shows cloudy antrum and chronic abscesses of upper right first molar. (See Fig. 8.) Exploration showed pus. Tooth was extracted, antrum drained for two weeks. Recovered.

F. C. J. Hospital patient. Anemia due to pyorrhea and pus pockets and apical abscesses. (See Figs. 9 and 10.) Extracted all teeth except four. The remaining teeth were given prophylactic treatment. Six weeks later, patient very much improved and able to leave the hospital.

Mr. E. Case of severe ulcerated stomatitis with trismis, resulting from infection from impacted lower third molar. (See Fig. 11.) Tooth extracted. Complete recovery.

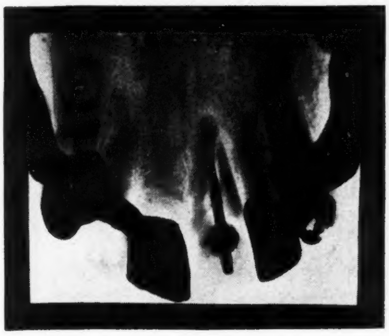

Fig. 12.

Miss H. Chronic arthritis for six years. Numerous focal lesions in mouth. Mention this case to illustrate fractured root with rarefied bone. (See Fig. 12.) Treatment just begun.

In cases of dislocation of mandible I have never had occasion to use the x-ray as all were easily reduced. However, there may come a time when the x-ray will be of great value.

In fractures we always make a radiograph before and after reduction and as indications arise.

I take many more radiographs as a result of having an x-ray laboratory in connection with my office than I would otherwise, and find it of much value both in the saving of time and in obtaining the best of results

CURRENT ORTHODONTIC LITERATURE

Edited by H. C. Pollock, D.D.S.

Some New Forms of Orthodontic Mechanism

Dr. E. H. Angle (*Dental Cosmos,* September, 1916) announces a new form of appliance and in this paper the difficulties involved in the use of the Angle Pin Tube Appliance are taken up. The need and demand for a modification of the original pin tube appliance is pointed out and a detailed description is given of the appliance, which it is believed will meet the requirements in which the pin tube appliance is lacking.

The subject of injudicious extraction of teeth is also discussed and the error of this former practice is called to mind. This discussion leads up to the establishing of normal function and correlated parts. He maintains that "On this basis only can orthodontic treatment be permanently beneficial and truly satisfactory for such only is in accordance with nature, and this is the true meaning of orthodontia."

Leading up to the appliance, however, other subjects are taken up which establish the principle upon which the appliance is based. Indications for early treatment of malocclusion is urged although a warning is issued against the needless interference with child dentures now so often practiced.

As to the physiologic application of force, the modern idea is presented as advocated in previous work by Noyes and Oppenheim as being the ideal force to be desired, and with this end in view, the improved appliance should operate in such a physiologic way as to meet such requirements. They should move teeth slowly, by slow, gentle force continuously applied which will not only move teeth far more rapidly than the great force, but does not inhibit the normal cellular activity as has been demonstrated to be true in using great force.

After describing in detail the technique of the new appliance, the advantages of the new device are summed up as follows:

"Force may be so controlled as to permit or to prevent the tipping of any tooth or teeth to any extent, or to compel the bodily movement of any tooth or teeth in either or both arches.

"This mechanism is of the greatest simplicity, of the maximum delicacy of parts, and with all unnecessary material eliminated. Hence it is of the least inconvenience to patients and the easiest to keep cleansed. It would seem that the mechanism is nearly ideal, not only for securing the necessary static force for anchorage and of dynamic force for tooth movement, but for directing and controlling this force so that all cellular change attending on tooth movement most nearly accords with the laws of physiology. It is also graceful in its proportions and not unpleasing in appearance. In a word, the principles of mechanics, art, and physiology do not conflict, but are made to harmonize beautifully and as was never possible in orthodontic mechanism before. It is so simple and easy to apply as greatly to lessen the usual work of the orthodontist

and the usual number of visits of patients. It is not expected that it will wholly supersede the pin and tube mechanism, neither will it wholly supplant the expansion arch in its round form with ligature attachments. In fact, the ligature attachment will be found to be of advantage in connection with the ribbon arch in the movement of premolars and of other teeth that may be so pronouncedly misplaced as to render impracticable the bending of the ribbon arch to gain bracket attachment with them until after they have first been moved into more favorable positions by means of ligatures. But in the great majority of cases the mechanism herein shown will be found to possess such obvious advantages in force control and in ease of application and operation, that I believe it will find a permanent place in orthodontia."

A few cases are shown which according to the author have been successfully treated by Ketcham, Gough, Strang, and Mendell, as well as those of the author.

The Teeth in Rickets

In a recent article J. Lawson Dick, M.D. (*British Journal of Dental Science,* August, 1916) states that in an examination of 1000 London school children of Jewish descent, 80 per cent showed distinct evidence of rickets. They were examined to show the relationship between nutrition and rickets.

Of the 386 rickety cases in which a record of permanent teeth could be taken, 42 per cent had normal teeth, and 28 per cent had defective teeth. 20 per cent of these showed hypoplasia frequently combined with decay, and 38 per cent had decayed teeth. This is not equivalent to saying that 42 per cent of school children have normal teeth. The records were taken at about the age of 12 or 13 years.

Of the cases with carious teeth the lower first molar was decayed in 80 per cent, the upper first molar was decayed in 30 per cent, and one or more premolars in 12.5 per cent.

The incisors, canines, and second molars were seldom decayed. The fact that the lower first molar decay is more prevalent is attributed rather to the main part of the enamel of the crown having been laid down in the first two years of life when rickety conditions are operative.

Dr. Dick says many of the conditions conducive to rickets are present in the parents of these children and *a priori* it might be expected that this would frequently be a congenital defect. He points out, however, that rickets is not a congenital condition and is another evidence of the care that nature takes that whatever else suffers the germ is at least protected during the intrauterine life.

A later form of hypoplasia is every now and then seen in which the two premolars and the second molars are affected, whilst the incisors, canines and first molars are not affected. This later form of hypoplasia must be due to influences acting on the child from the second to the sixth year. Association has been recognized between lamellar cataract and hypoplastic teeth. Mr. Norman Bennett collected twenty-two cases of lamellar cataract, all of which showed well-defined hypoplasia in the permanent teeth, and in thirteen cases there was a history of convulsions whilst teething.

The International Journal of Orthodontia

PUBLISHED THE FIFTEENTH OF EVERY MONTH BY

THE C. V. MOSBY CO., 801-807 Metropolitan Bldg., St. Louis, Mo.

Foreign Depots—*Great Britain*—Henry Kimpton, 263 High Holborn, London, W. C.; *Australasia*—Stirling & Co., 317 Collins Street, Modern Chambers, Melbourne; *India*—"Practical Medicine," Egerton Street, Delhi; *Porto Rico*—Pedro C. Timothee, Rafael Cordero 68, San Juan, P. R.

Subscription Rates—Single Copies, 30 cents. To anywhere in United States, Cuba, Porto Rico, Canal Zone, Mexico, Hawaii and Philippine Islands, $3.00 per year in advance. Under foreign postage, $3.40. English price: 15/ per annum, 1/6 per number. Volume begins with January and ends with December of each year.

Remittances—Remittances for subscriptions should be made by check, draft, postoffice or express money order, or registered letter, payable to the publishers, The C. V. Mosby Company.

Contributions—The editor will be pleased to consider the publication of original communications of merit on orthodontic and allied subjects, which must be contributed solely to this journal.

Opinions—Neither the editor nor the publisher hold themselves responsible for the opinions of contributors, nor are they responsible for other than editorial statements.

Reprints—Since it is not desirable to hold type standing longer than absolutely necessary, all requests for reprints should be made at time of submitting manuscript for publication. Rate card will be sent with galley proof.

Communications—Contributed articles, illustrations, letters, books for review, and all other matter pertaining to the editorial department should be addressed to the Editor, Doctor Martin Dewey, 1016 East Armour Boulevard, Kansas City, Mo. All communications in regard to advertising, subscriptions, change of address, etc., should be addressed to the publishers, The C. V. Mosby Company, 801-807 Metropolitan Building, St. Louis, Mo.

Illustrations—Such halftones and zinc etchings as in the judgment of the editor are necessary to illustrate articles will be furnished when photographs or drawings are supplied by the authors of said articles.

Advertisements—Objectionable advertisements will not be accepted for publication in this journal. Forms close first of month preceding date of issue. Advertising rates and sizes on application.

Change of Address—The publishers should be advised of change of subscriber's address about fifteen days before date of issue, with both new and old addresses given.

Nonreceipt of Copies—Complaints for nonreceipt of copies or requests for extra numbers must be received on or before the fifteenth of the month of publication; otherwise the supply is apt to be exhausted.

Entered at the Post Office at St. Louis, Mo., as Second-Class Matter

EDITORIALS

The Proceedings of the American Society of Orthodontists

IN view of the fact that the Board of Censors of the American Society of Orthodontists at its last meeting in July at Pittsburgh voted down the proposition made by the editors of the *International Journal of Orthodontia* to publish the proceedings of the Society, and in justice to those members who were unable to attend the Pittsburgh meeting, we want to take this opportunity to state the facts in the case.

We have always believed that the proceedings of the American Society of Orthodontists would better serve the interests of everyone concerned by being published in the *International Journal of Orthodontia,* which is published for the members of the dental profession who are interested in orthodontia, and for the benefit of humanity by furthering orthodontia so that the dental profession may be able to render better service to the public.

It is a fact that cannot be disputed that the proceedings of the American Society of Orthodontists as published in *Items of Interest* have appeared over

a period of months after each meeting, which is to say the least very detrimental and a disadvantage to the members who do not attend the meetings.

At the present time, the membership of the American Society is something less than eighty, and out of this number about thirty members were in attendance at Pittsburgh. While it is true that more men attended the meeting at Pittsburgh than the thirty active members of the society, yet the only vote which came up that showed a test of the membership was the vote in regard to the proposition as to whether the American Society should publish their proceedings in the *International Journal of Orthodontia.* On this proposition there were just twenty-nine votes cast, two members not voting. Therefore it is safe to say that about a third of the members attend the annual meetings. Consequently it appears to us that it would be a decided advantage if some plan could be perfected whereby the other two-thirds who have paid dues for a number of years and have continued to support the Society in a financial way, would be given some consideration in regard to the publication of the proceedings. The statement was made at Pittsburgh that the absent members should not be shown consideration, because, if they were interested, they would attend the meeting. It seems to us that any one who is willing to pay his annual dues of five dollars is somewhat interested in orthodontia, and is at least entitled to more of a hearing than he was given at Pittsburgh.

In fairness to those absent members who were in favor of our proposition, we will say we still believe that the *International Journal of Orthodontia* could serve the interest of all of the members of the American Society of Orthodontists better than *Items of Interest.* Of course, we will agree that we could probably not serve the interest of a few as well as our esteemed contemporary, but a few should not dominate the other three-fourths of the Society.

We are criticized for making the campaign open and above board to obtain the proceedings, for it seems to be a standard among some men both in national and dental politics that anything which is done in a political way should be done under cover. For the benefit of those opposed to our policy, we will therefore make the statement at this time that we still insist that the proceedings of the Society should be published in a journal devoted to orthodontia, and we will bend every effort towards accomplishing that purpose, and the purpose will be accomplished openly and above board.

We were called unethical and undignified by certain members of the American Society because we insisted upon asking for the proceedings, and they even went so far as to tell us that we had no right to ask for them inasmuch as they had been published so long by *Items of Interest.* As an equal argument, we might say that a man has no right to buy an automobile because his father rode in an ox cart. If there is to be no progress in any branch of orthodontia, then there should be no progress in the publication of the proceedings.

If dental journals and dental literature are to remain the same as they were twenty years ago, if there is to be no advancement made in the dental profession, or in orthodontic science, then we say leave things as they are because they have always been that way.

The argument was also made that, owing to the fact that *Items of Interest* has a larger circulation than the *International Journal of Orthodontia,* the pa-

pers of the society would be given more publicity, and it would be of more benefit to the men who wrote the papers by having them receive that publicity than if they were published in the *International Journal of Orthodontia.* Again you have the question of personal ambition entering into the argument. In other words, the man who wrote the paper did not write it for the advancement of orthodontia, but for his own personal advancement, and believes that his personal interest would be served better by having the paper published in a trade journal with a wide circulation.

If circulation is the thing desired, we might suggest that the proceedings of the American Society of Orthodontists be published in the Saturday Evening Post, The Ladies Home Journal, or some other magazine which has a larger circulation than any dental journal published at the present time.

We take this opportunity to express our gratitude to the members of the American Society of Orthodontia who were unable to attend the meeting but supported us in our endeavor to secure the proceedings. We wish to assure them that their interests are our interests regardless of what a few may say, and that as long as the *International Journal of Orthodontia* is published, regardless of the fact that some few may consider us "unethical and undignified," we will be striving for the advancement of orthodontia in such a manner as to do the greatest good for the dental profession and the public, and therefore, will always be striving to obtain the proceedings of the American Society so that they may be published in a manner to serve the greatest number of men interested in orthodontia in the shortest possible length of time.

A Plea for More Careful Consideration of Scientific Subjects Before Orthodontic Societies

IT is our observation that papers on scientific subjects do not receive the consideration they merit when presented before orthodontic societies. Any paper which does not deal with some phase of mechanics receives very little consideration or discussion. There is no question that mechanics plays an important part in orthodontia, but there are problems which require more attention and which must be considered before orthodontia can take its place among the real sciences.

We need only to call attention to four papers which were presented before the American Society of Orthodontists at Pittsburgh in July. All of these papers were read by members of the Society, but two of them were on scientific subjects which required much time to prepare and a great amount of search through the literature to collect the data presented. The others dealing with mechanical problems were also excellent papers and probably required considerable labor to prepare. The papers on the mechanical subjects were well presented and much time was given to their discussion, but it does seem rather unfortunate that so little attention should be given to the scientific papers presented.

We refer particularly to the papers presented by Dr. O. W. White and

Dr. B. W. Weinberger. The paper by Dr. White discussed cell metabolistic problems, a subject that should be of more than ordinary interest to every orthodontist. Dr. White's paper was undoubtedly one of the best presentations of the question dealing with the general cell metabolism as related to malocclusions ever rendered, one that required considerable time and labor to prepare, and out of justice to the essayist should have been discussed by at least some of the members present. Yet there was practically no discussion of this paper, due principally to the fact that so few men were prepared to discuss such a subject.

The paper by Dr. Weinberger deals with the question of prenatal influences on the production of malocclusion, or the mesio- or disto-clusion of the mandible as a result of constitutional or general conditions. This is a problem that has been much discussed in the past, but we have never before heard the subject so accurately and scientifically presented. As in the case of the paper by Dr. White so also here was there no attempt at discussion.

We simply recall these instances to show the tendency of the American Society of Orthodontists, which is not only the trend of orthodontists but also that of the dental profession as a whole. We hope that the day is not far distant when the orthodontic profession, and in fact the entire dental profession, will awaken to the need of a more definite scientific knowledge and come to the realization that they can not devote all of their time in programs at meetings to the discussion of elementary subjects if they ever expect to elevate the profession to the highest possible plane in the scientific world.

We trust that in the future the Board of Censors will attempt to have men on the program who can and will discuss papers of a scientific nature, and when papers similar to those presented by Drs. White and Weinberger are read, there will be at least four or five men in the audience who are capable of making an intelligent discussion of the subject.

The Crimes of Orthodontia

THOSE who have been engaged in the practice of orthodontia for a number of years and are so situated that they come in close contact with the members of the dental profession and have heard the discussions of dentists at various dental society meetings, might be led to believe that orthodontia has inflicted a great many crimes upon the public and forced a great many ills upon the dental profession. We know of men in the dental profession, unfortunately occupying prominent positions, who are very greatly opposed to the correction of malocclusion of the teeth. Much of this opposition seems to be because of selfish motives, which is, however, an element too small to be worthy of consideration. There is another side of the question with which we are confronted that must be met squarely. We find men who are condemning the treatment of malocclusion upon the argument that the regulating appliance causes the decay of the teeth. We find them going so far that, when they see a patient who has had a regulating appliance upon his teeth, they claim every cavity in the teeth, regardless of where

it is located, has been produced by the regulating appliance. They are talking this so strongly to their patients that people are discouraged from having malocclusions treated, because they have been told that the regulating appliance will decay the teeth. These same men forget that the greater part of their practice consists of filling the teeth of patients who have never had a regulating appliance in their mouth. In other words, since teeth decay which have never been in malocclusion and teeth decay which have never had an appliance on them, why then should they not be expected to decay when they do have the appliance on? We have seen cavities in the occlusal surfaces of the molars which have developed because of fissures, and they have been attributed to the regulating appliances, which, of course, was entirely wrong. We have also seen, in the practice of the same men who are condemning the treatment of malocclusion, fillings, crowns, and bridges, which are far from perfect, and which could be very easily condemned and criticized if one was inclined to do so. In fact, taking the case as a whole, there are probably more failures as the result of faulty dental operations in the dental profession than there are decayed teeth or failures in the practice of orthodontia, regardless of what plan or method has been pursued.

It is our belief that the percentage of failures in the treatment of malocclusion is smaller than the percentage of failures in any other line of dental or medical work. However, as we have said before, there is a question of "crime" laid at the door of orthodontia, which must be met, and that is that in certain cases the decay of the teeth has been produced by the regulating appliance. The problem of modern orthodontia then is to eliminate the cases of decay which have been produced by the appliance, but these cases are by no means as great in number as many dental practitioners would have us believe. In fact, the decay of the teeth can be absolutely controlled, providing the case be treated with that idea in view, or by using the knowledge that we have at the present time. It is an absolute fact that in the hands of orthodontists who use removable regulating appliances the decay of the teeth is practically nothing.

When fixed appliances are used, it is found that the decay of the teeth is limited to those who employ the noble metals. Gold and platinum and iridioplatinum, without the question of a doubt, have no antiseptic properties, and the tooth in contact with such a metal is very liable to decay. The decay of the teeth will necessarily have to be controlled by the constructioin of appliances in such a manner that they can be cleaned, which is taken care of in the removable appliance; if the fixed appliance is used, it should be made from some metal or substance which is antiseptic and prohibits growth of acid-forming organisms. This can be done by the use of such metals as contain an alloy of zinc or copper, which metals are being used quite satisfactorily at the present time. It is absolutely wrong for the orthodontist to become wedded to one particular metal or insist on using nothing but noble metals, when as a matter of fact, the dental profession is proving through observation that the use of the noble metals invites decay. It is much better to use a metal which does not look so well in the mouth, which may oxidize occasionally, which has been classed as the base metal, and which has a known antiseptic property, in preference to a metal which is known to produce decay and the resulting crimes which are laid at the door of orthodontia by the members of the dental profession who are as a rule opposed to specialization any-

way. As stated before, there are not as many decayed teeth resulting from the use of orthodontic appliances as some would have us believe, but we do believe that there is entirely too many at the present time. There is hope in the future that orthodontists will do much more than they have in the past towards eliminating the decay of the teeth, thereby removing the possibility of criticism by certain men who are accusing orthodontia of a crime, when it is really not its fault.

The Appellate Court Decision of the Taggart Inlay Case

IT has been some time since the question arose in the dental profession as regards the validity of the Taggart inlay patent. Many practitioners who were formerly friends have become enemies over this question, and while, as a whole, it has affected orthodontia very little, nevertheless it is a question which has a much more important bearing upon orthodontia than some would imagine. While we have no personal interest in the matter one way or the other, never having made an inlay in our life by the Taggart Process, we consequently cannot be accused of some of the motives others have been accused of. However, we believe that orthodontists and the dental profession as a whole should have a clear conception of the scope of the Taggart case, and what the latest decision means.

On June 13, 1916, the United States Circuit Court of Appeals for the Seventh Circuit granted a decision that Dr. Taggart could not undertake to enforce his claim by bringing suit against the dentists jointly or collectively. This question has a great deal of bearing upon further suits which might be filed, but has no bearing upon the validity or scope of the Taggart Process Patents, which were not involved in this decision. The court simply decided that Dr. Taggart did not have a right to sue dentists collectively in a single suit, and was brought before the Court of Appeals as the result of the following conditions:

About three years ago, Dr. Taggart's attorney began sending letters to the dentists of Chicago and northern Illinois, demanding that they pay $150 in five days, and threatening to commence an infringement suit if they failed to comply. Separate suits were immediately begun against a number of dentists. As a resut of such suits, the Dentists Mutual Protective Alliance was organized, and its attorneys undertook the defense of the members against whom the separate suits had been brought. Some against whom the suits had been filed settled according to Dr. Taggart's suggestions. Dr. Taggart then abandoned his separate suits against those who would not settle, and brought a single suit against scores of dentists adding to that suit from month to month. Finally, after 523 defendants had been brought into one suit, Judge K. M. Landis, of the United States District Court, before whom the case was pending, ordered that Dr. Taggart should join no more dentists as defendants. When this collective suit came to trial in June, 1915, the first question to be raised was that of Dr. Taggart's right to deprive each man of his day in court by suing all jointly. Upon this question, Judge F. A. Geiger, before whom the matter was tried, held that there was an improper joinder as to all of the defendants save one.

The trial then proceeded as to the one defendant selected by Dr. Taggart and twelve others selected and volunteered by the Alliance in order to secure

a series of test cases in which every possible question as to the merits of Dr. Taggart's patents and his claims of infringement might be finally determined. These test cases are still pending in the District Court of Chicago, and are in no way affected by the decision of June 13.

The scope of the decision of June 13 decided Dr. Taggart can not maintain a single suit against dentists collectively, and it was upon this phase, a this phase alone, that the court of appeals has just rendered the decision.

There is nothing in this decision which will prevent Dr. Taggart from filing suits against individual dentists, but it will prevent him from filing a joint suit against a large number of dentists in one locality. Owing to the large amount of trouble to which a number of men have been placed because of these process patents, we hope that the Dental Alliance will succeed in securing a sufficient membership to enable them to give a thorough defense of each test case, and decide the question as to the validity of the process patent for always.

Sixtieth Anniversary Meeting of the St. Louis Dental Society

TO appropriately celebrate the sixtieth anniversary of the St. Louis Dental Society, which has been in continuous activity since 1856, a program of exceptional excellence is being prepared for the week of November 16, 1916.

The St. Louis dentists intend to make this occasion an important event in the dental history of the country, and one which shall eclipse in interest and attendance all former efforts of local societies.

As a fitting tribute to Black, McKellops, Forbes, Morrison, Spalding, and others who founded and maintained this society in the pioneer days of the profession, the anniversary will portray the advance of dentistry from that epoch-making period resulting from the organization of societies.

A series of scientific papers along the advanced lines of present interest will disclose some amazing knowledge from research work now progressing under the supervision of the foremost teachers and original investigators. A national representation of individual clinicians and co-operative clinics by societies and technic clubs will supply a most complete course of practical instruction.

This is the meeting you will hear more about, and will regret if you miss. Additional information will be published as the time approaches, and invitations will solicit the representation of all societies. For the convenience of visitors from a distance the literary and clinical program will be limited to three days—November 16, 17, 18, 1916.